GAUTENG DEPARTMENT OF EDUCATION
SENIOR CERTIFICATE EXAMINATION

FITTING AND TURNING SG

TIME: 3 hours

MARKS: 200

REQUIREMENTS:

- Pocket calculator and drawing instruments

INSTRUCTIONS:

- Answer ALL the questions.
- Unless otherwise indicated, all dimensions are in millimetres.
- Number your answers in accordance with the question paper.
- An information sheet is on pages 9 to 11 of this paper.

QUESTION 1

Answer the following questions on the **answer sheet** on the **inside cover** of your **answer book**. For each question, indicate the correct answer(s) by drawing a cross (**X**) over the appropriate letter(s) on the answer sheet. The mark allocation on the right is an indication of the number of correct answers for each question.

1.1 A gear tooth vernier is used to measure the _____ and _____ of a gear.

A. circular pitch
B. chordal addendum
C. clearance
D. chordal thickness (2)

1.2 A square thread has a pitch of 8 mm. What is the depth of the thread?

A. 4 mm
B. 8 mm
C. 16 mm
D. 6 mm (1)

1.3 Friction can have devastating consequences if machines are not properly maintained. Point out the circumstances where friction can cause damage to machines.

A. Machine bearings run dry
B. No lubrication on belt drives
C. No lubrication on machine slides
D. None of the above (2)

1.4 Gauge blocks should be handled with care. Which of the following are INCORRECT?

A. Coating the blocks with oil after use
B. Exposing them to heat
C. Cleaning them
D. Wringing the blocks with bare hands (2)

1.5 Point of action guards are used on _____.

A. gearboxes
B. rotating shaft-ends
C. bandsaws
D. guillotines (2)

1.6 Shear stress is applicable when _____.

A. two surfaces are pressed together
B. a steel plate is being cut on a guillotine
C. two surfaces slide over one another
D. two plates bolted together are subjected to a tensile force (2)

1.7 Before starting to cut a screw thread, the machinist must know the following:

A. The type of screw thread
B. The type of cutting tool to be used
C. If it will be a left- or right-hand thread
D. The type of material that must be used (2)

1.8 From the list below, choose the CORRECT reason for using sector arms on a dividing head.

A. It helps with differential indexing
B. It facilitates rapid indexing
C. It helps the operator to index the correct number of holes on the index plate
D. It assists the operator to set up the change gears (1)

1.9 Helical gears can transmit more power than spur gears. The reason for this is that _____.

A. the helix angle on helical gears is larger than that on spur gears
B. helical gears can be cut on much larger diameter shafts
C. power is always distributed over two teeth
D. the drive is smoother (1)

[15]

Say whether the following statements are TRUE or FALSE. Write the word TRUE or FALSE next to the appropriate question number.

1.10 The longer button in a set of toolmakers' buttons is used for the set-up to drill a hole in a plate on a milling machine.

1.11 Differential indexing is only used to index a large number of holes.

1.12 No change gears are used when helical milling is performed.

1.13 Friction is treated as an advantage when grinding a workpiece on a universal grinder.

1.14 Square threads have been replaced by the ACME thread because ACME threads exert end thrust in only one direction. (10)

[25]

QUESTION 2

2.1 Name TWO advantages and TWO disadvantages of the process layout of machines. (4)

2.2 A left-hand internal square thread with a pitch of 8 mm must be cut on a centre lathe. The outside diameter of the shaft must be 90 mm and the size of the hole must be 70 mm. You are given a rough workpiece.

2.2.1 Make a neat sketch of the cutting tool.

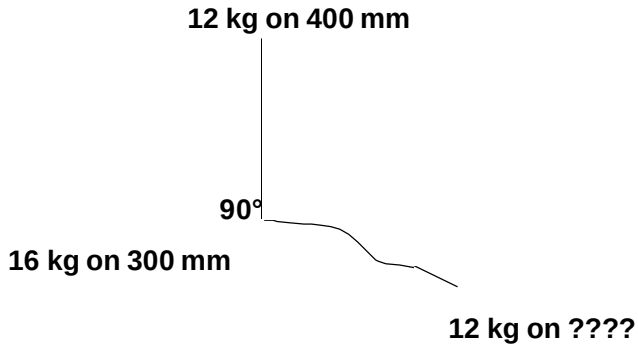
2.2.2 Explain how the work must be carried out. (10)

2.3 Calculate the indexing for each of the following:

2.3.1 A spur gear with 28 teeth (3)

2.3.2 An angle of 16º 40' (4)

2.4 A two-armed cranked lever must be machined on a centre lathe. The sketch shows a diagrammatical representation of the lever mounted on a faceplate. Determine graphically the distance from the centre of the faceplate at which a 12 kg balance mass must be placed to balance the set-up. Draw up a mass-distance table to facilitate your answer. Use a scale of 1 mm = 50 kg.mm for your vector diagram. Also determine the angle between the 16 kg arm and the balance mass.



(14)
[35]

QUESTION 3

3.1 A helical gear with 48 teeth and a real module of 2,684 mm must be machined on a milling machine. The helix angle of the gear is 34º. The pitch of the machine lead screw is 6 mm and the dividing head ratio is 40:1 Calculate the

3.1.1 pitch circle diameter of the gear.

3.1.2 outside diameter of the gear.

3.1.3 number of teeth marked on the cutter.

3.1.4 lead of the gear.

3.1.5 lead of the machine.

3.1.6 change gears needed. (19)

3.2 A force of 200 kN is applied on the plunger of a hydraulic lifting machine. The pressure on the liquid is found to be 500 MPa. Calculate the diameter of the plunger. (7)

3.3 A 7º primary clearance angle is required on a 150 mm diameter side and face milling cutter. A disc grinding wheel, 150 mm in diameter, is used for the procedure.

3.3.1 Draw a neat sketch of the set-up to indicate the position of the tooth rest. (6)

3.3.2 Calculate the offset of the tooth rest. (3)
[35]

QUESTION 4

4.1 Draw a neat sketch to illustrate the gear arrangement (dividing head and milling machine lead screw) when

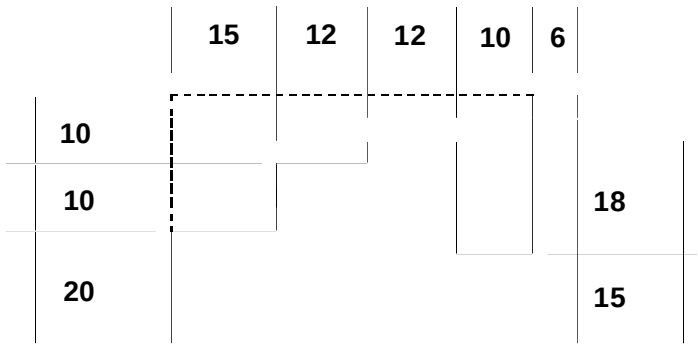
4.1.1 a gear rack is machined.

4.1.2 differential indexing is done. (12)

4.2 A metal block must be shaped as indicated on the sketch below. The process must be carried out in a single cut along the length of the block.

4.2.1 Describe in detail, with the aid of a sketch, how you would set up the milling cutters on the arbour and proceed to cut the shaped block. (6)

4.2.2 Name the type of milling operation used in this process. (2)

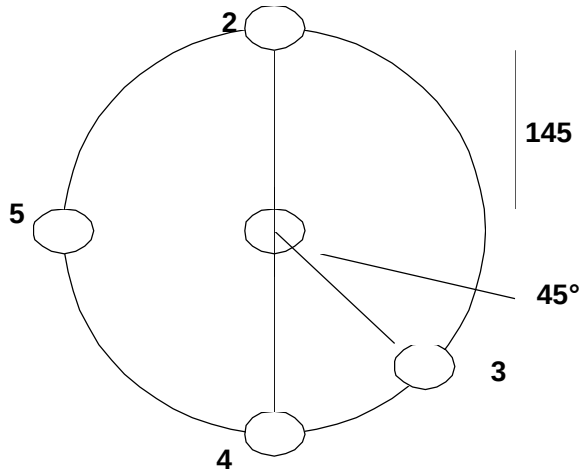


4.3 The following sketch shows five holes drilled on a round workpiece. To position the holes accurately, 12 mm diameter toolmakers' buttons are used to set up the work on the lathe. Calculate the

4.3.1 pitch circle diameter of the holes. (4)

4.3.2 distance between buttons no. **3** and no. **5**. (9)

4.3.3 What kind of triangle is formed if the centres of holes **2**, **3** and **5** are joined? (2)



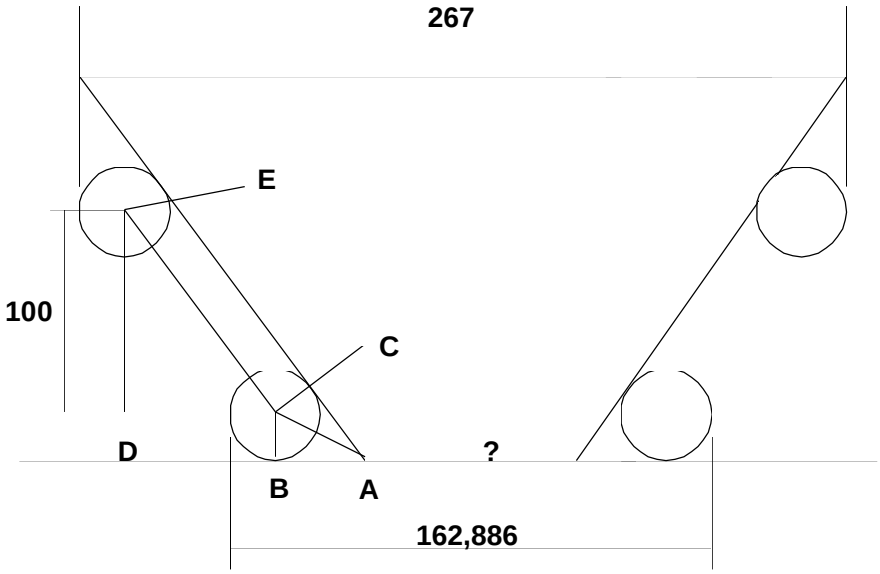
[35]

QUESTION 5

5.1 The taper plug gauge in the sketch below must be tested for accuracy using 20 mm diameter rollers.

5.1.1 Prove that the included angle (?) of the plug gauge is 55º. (8)

5.1.2 Calculate the small diameter of the gauge. (9)



5.2 Name FOUR advantages obtained when using numerically controlled machines. (4)

5.3 Name TWO disadvantages of grinding away from the cutting edge when sharpening the teeth of a milling cutter. (2)

5.4 The roof of a school pavilion has a mass of 10 000 kg and is supported by five similar solid pillars. If the total stress in the five pillars is only 12 MPa, calculate the diameter of each pillar.
Take **g** as 10m/s². (9)

5.5 Name TWO advantages of up-cut milling. (2)

5.6 Name ONE disadvantage of climb milling. (1)
[35]

QUESTION 6

6.1 The sketch below shows a diagrammatical representation of a hydraulic press. Force F1, acting on piston **A**, is 500 N and the diameter of piston A is 50 mm. Calculate the

6.1.1 pressure in the system. (5)

6.1.2 load that can be lifted at the ram **B** if the diameter of the ram is 150 mm. (8)

6.2 A two-start external square thread with a pitch of 6 mm and an outside diameter of 65,5 mm must be cut on a centre lathe. The clearance angle on the cutting tool is 3º. Calculate the

6.2.1 leading angle on the cutting tool.
6.2.2 following angle on the cutting tool.
6.2.3 cutting depth of the thread. (13)

6.3 Mane THREE good reasons for balancing a workpiece before machining it on a centre lathe. (3)

6.4 Calculate the cutting depth for a helical gear with a real module of 6,59 mm and a helix angle of 24º 27'. (6)

[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 OD = m (t + 2)

3.5.8 m = $\frac{OD}{T+2}$

3.5.9 Circular pitch = $\pi m \left[\frac{mT}{2} (1 - \cos \frac{90^0}{T}) \right]$

3.5.10 Chordal width = $mt \sin \frac{90^\circ}{T}$

3.5.11 Circular pitch = πm

3.6 Helical gears = m (T + 2)

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 = π x PCD x cot θ

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 = $\frac{Dr}{G} = \frac{(A-N)}{A} \text{ x } \frac{40}{1}$

3.7.4 Rack:

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

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