SENIOR CERTIFICATE EXAMINATION

FEBRUARY / MARCH

2007

FITTING AND TURNING

SG

705-2/0 E

FITTING & TURNING SG

705 2 0E SG

11 pages

X05

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 Straddle milling is _____.

A. used when a large flat surface must be produced
B. where the milling cutters are separated by a spacing collar
C. when a number of different size cutters are used at the same time
D. used when a large number of equal parts must be machined (2)

1.2 Rapid indexing is used when _____.

A. a large number of parts must be machined
B. the indexing is easy
C. a rack must be machined
D. helical gears are cut (1)

1.3 Friction may be applied advantageously in a workshop. Choose examples of the effective use of friction from the list below.

A. Lathe cutting tools
B. Machine bearings
C. Machine clutches
D. Belt drives (2)

1.4 The aim of maintenance is to _____.

A. prevent workers from working overtime
B. keep workers on their toes
C. cut the cost of replacement parts
D. minimise time lost due to breakages (2)

1.5 Factors that influence the magnitude of the helix angle of a screw thread are: _____.

A. Outside diameter of the work
B. Root diameter of the thread
C. Primary clearance angle of the cutting tool
D. Lead of the screw thread (2)

1.6 The following are essential features of a well-designed sine bar.

A. Rollers must be perfectly round.
B. All faces of the sine bar must be ground.
C. Centre distance of the rollers must be precise.
D. Only rollers may be used. (2)

1.7 An out of balance workpiece is being machined on a centre lathe. One or more of the following may occur.

A. The work piece will not be perfectly round.
B. The machine chuck will warp.
C. The lathe bed will distort.
D. The machine spindle will bend. (2)

1.8 During differential indexing the index plate rotates with or against the rotation of the index crank. The index plate will rotate WITH the index crank when the ratio of the change gears _____.

A. has a negative value
B. has a positive value
C. is an improper fraction
D. is a proper fraction (1)

1.9 Multi-start screw threads are preferred where _____.

A. rapid radial movement is required
B. the thread pitch is very small
C. large diameter shafts must be threaded
D. the working depth of the screw thread is large (1)

[15]

Say whether the following statements are TRUE or FALSE. Simply write the words TRUE or FALSE next to the appropriate question number.

1.10 Helical milling and differential indexing can be done simultaneously.

1.11 Stress is directly proportional to the load.

1.12 By using numerically controlled machines, you may obtain a higher degree of accuracy.

1.13 Static balancing is always done when the workpiece is still in motion.

1.14 Change gears must always be used when cutting a gear rack. (10)

[25]

QUESTION 2

2.1 Mention TWO advantages and TWO disadvantages of the product layout of machines in a workshop. (4)

2.2 A circular hole must be punched in a 10 mm thick steel plate. The force applied is 320 kN and the shear stress in the plate may not exceed 370 MPa. Calculate the maximum size hole that can be punched. Note that the area under stress is the circumference of the hole multiplied by the thickness of the plate. (9)

2.3 The piston of a hydraulic jack can exert a force of 25 kN when a load of 400 N is applied on the plunger. The diameter of the plunger is 100 mm. Calculate the

2.3.1 diameter of the piston. (8)

2.3.2 pressure on the liquid in the jack. (5)

2.4 A 100 mm diameter cup grinding wheel is used to sharpen the teeth of a 200 mm diameter side and face milling cutter. The primary clearance angle of the teeth is 4°.

2.4.1 Draw a sketch of the set up to show the position of the tooth rest. (6)

2.4.2 Calculate the off-set of the tooth rest to grind the required clearance angle. (3)

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QUESTION 3

3.1 A three-start external square thread with a pitch of 4 mm must be machined on a centre lathe. The root diameter of the thread is 52,6 mm and the primary clearance angle of the cutting tool is 3°. Calculate the

3.1.1 helix angle of the thread.

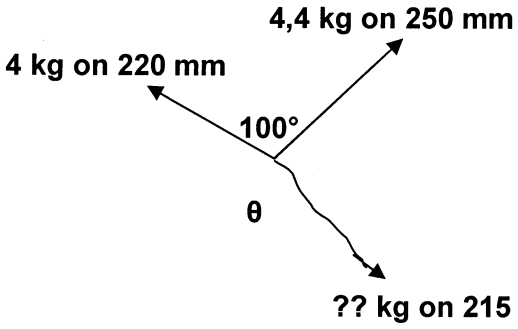
3.1.2 cutting depth of the thread.

3.1.3 leading angle of the cutting tool.

3.1.4 following angle of the cutting tool. (13)

3.2 The sketch below shows an unbalanced face plate with two mass pieces. Determine graphically the mass of a third mass piece placed at a distance of 215 mm from the centre of the face plate to balance the face plate. Also determine the angle θ. Complete the mass-distance table and use a scale of 1cm = 100 kg.mm for your vector diagram.

Mass	Dist	Mass/Dist	To scale (mm)
4 kg	220 mm		
4,4 kg	250 mm		
	215 mm		

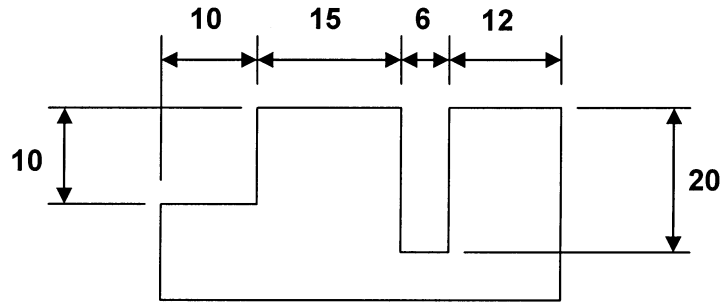


(14)

3.3 Two grooves must be machined in a steel plate as the sketch indicates. The milling operation must be performed in a single cut along the length of the plate.

3.3.1 Briefly explain, with the aid of a sketch, how you would proceed to cut the grooves. Be precise in the setting up of the cutters. (6)

3.3.2 What type of milling operation is used for this kind of work? (2)



[35]

QUESTION 4

4.1 A spur gear with 89 teeth must be machined on a milling machine. The dividing head ratio is 40:1. Choose 90 teeth and calculate the

4.1.1 required indexing.

4.1.2 necessary change gears needed to mill the gear.

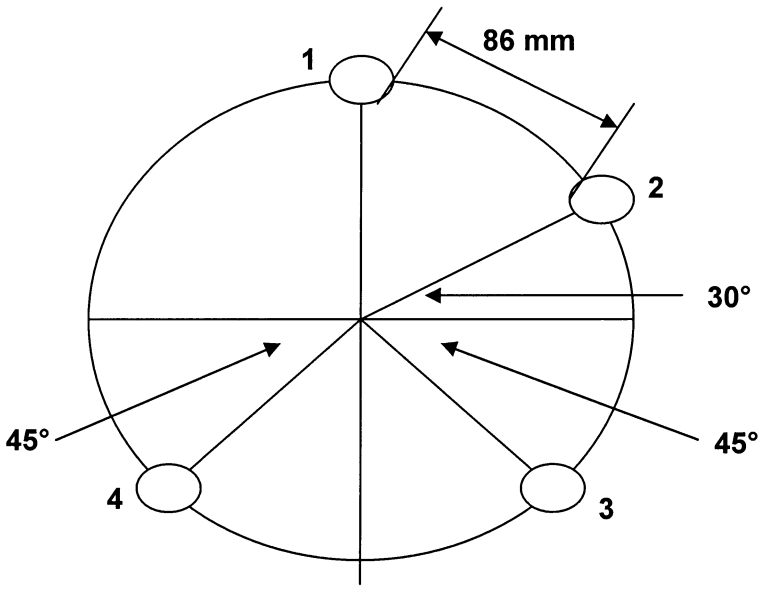
4.1.3 rotational direction of the index plate. (9)

4.2 A right hand external ACME screw thread with a pitch of 8 mm must be machined in stages on a centre lathe. Describe, step by step and with the aid of a series of sketches, how you would execute the work. Begin your answer by explaining how the machine must be set up. The shaft is already turned down to size. (10)

4.3 Four holes must be drilled on a circular steel plate as indicated on the sketch. Toolmakers' buttons with a diameter of 18 mm are used to set the work up on a lathe. Calculate the

4.3.1 PCD of the holes. (9)

4.3.2 centre distance of buttons no. 3 and no. 4. (7)



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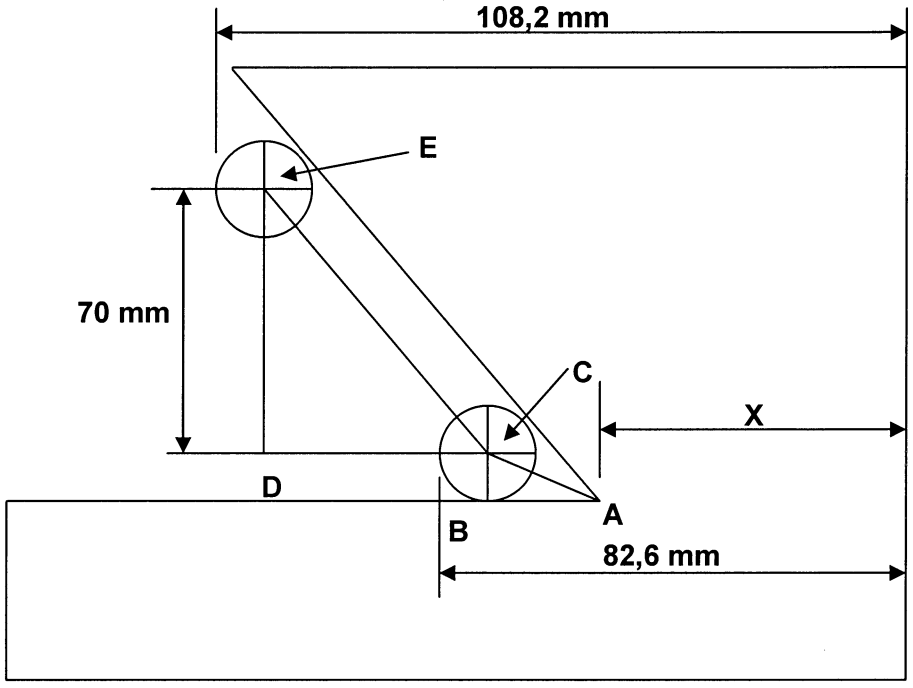
QUESTION 5

5.1 Refer to the sketch below and calculate the distance marked **X**. The rollers are 18 mm in diameter. Draw a neat sketch of the set-up and show ALL your calculations.



(15)

5.2 A liquid pressure of 150 MPa is required in a hydraulic press. Calculate the force on the piston to obtain the required pressure. The diameter of the piston is 60 mm. (7)

5.3 A 6 mm keyway must be cut in a 60 mm diameter round shaft. Explain, with the aid of a sketch, how the shaft should be centred under a 6 mm side and face milling cutter. (6)

5.4 Briefly describe the difference between **straddle milling** and **gang milling**. (4)

5.5 When a program is written for a numerically controlled machine, the programmer must allow for radius compensation, diameter compensation or both. Sometimes no compensation is necessary. State where or when each of these three must be applied. (3)

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QUESTION 6

6.1 An involute gear cutter with a normal module of 3,8 mm is used to mill a helical gear with a helix angle of 30°. The gear has 94 teeth. Calculate the

6.1.1 pitch circle diameter of the gear teeth. (5)

6.1.2 number of teeth marked on the cutter. (3)

6.1.3 lead of the gear. (2)

6.1.4 chordal addendum of the gear. (4)

6.1.5 chordal thickness of the gear. (3)

6.2 Name FOUR functions of a universal dividing head. (4)

6.3 Draw a neat sketch of the gear arrangement (dividing head and lead screw) when a helical gear must be machined. (6)

6.4 Mention THREE important factors to be taken into account when the primary clearance angle of a milling cutter is determined. (3)

6.5 What is meant when a workpiece, under perfect conditions, is **dynamically balanced**? (3)

6.6 Name TWO characteristics to distinguish a plain horizontal milling machine from a universal milling machine. (2)

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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. Formules

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

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

3.5.11 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 = $\frac{PCD}{m_w}$

3.6.7 m_n = $m_w \cos\theta$

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 : $\ell = \pi \times SSD \times \cot\theta$

or

$\ell = \frac{\pi x SSD}{\tan\theta}$

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

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 $\frac{Dr}{G} = \frac{L}{\ell}$

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

3.7.4 Rack:

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

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 η = $\frac{Lead}{\pi D_m}$

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