basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

MECHANICAL TECHNOLOGY: FITTING AND MACHINING

EXEMPLAR 2018

MARKING GUIDELINES

MARKS: 200

These marking guidelines consist of 20 pages.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS (GENERIC)

1.1 A ✓ (1)

1.2 B ✓ (1)

1.3 B ✓ (1)

1.4 B ✓ (1)

1.5 C ✓ (1)

1.6 C ✓ (1)
[6]

QUESTION 2: SAFETY (GENERIC)

2.1 **Machine safety rule:**
Switch machine off after use. ✓ (1)

2.2 **Drill press safety precautions:**
Clamp the work piece securely to the table and do not hold it by hand. ✓ (1)

2.3 **Hydraulic press safety rules:**
- Predetermined pressure must not be exceeded. ✓
- Pressure gauge must be tested regularly and replaced if malfunction occurs. ✓
- The platform must be rigid and square to the cylinder. ✓
- Objects to be pressed must be placed in suitable jigs. ✓
- Ensure that the direction of pressure is always at 90° to the object. ✓
- Only prescribed equipment must be used. ✓ **(Any 2 x 1)** (2)

2.4 **Reasons for wearing surgical gloves:**
- To prevent HIV/Aids or any blood related infections. ✓
- To prevent contamination of the open wounds. ✓ (2)

2.5 **Gas cylinder safety precautions:**
- Always store and use gas cylinders in an upright position. ✓
- Never stack cylinders on top of one another. ✓
- Do not bang or work on the cylinders. ✓
- Never allow cylinders to fall. ✓
- No oil and grease should come into contact with gas cylinders or fittings. ✓
- Keep the caps on the cylinders for protection. ✓ **(Any 2 x 1)** (2)

2.6 **Responsibility of employer:**
- Provide and maintain working systems, work area, equipment and tools in a safe condition. ✓
- Eliminate or reduce any hazard or potential hazard. ✓
- Produce, handle, store and transport goods safely. ✓
- Ensure that every person employed complies with the requirements of this Act. ✓
- Enforce measures if necessary in the interest of health and safety. ✓
- Appoint a person who is trained and who have the authority to ensure that employee take precautionary measures. ✓ **(Any 1 x 1)** (1)

2.7 **Responsibility of employee:**
- Pay attention to his/her own and other people's health and safety. ✓
- Co-operate with the employer regarding the Act. ✓
- Carry out a lawful order given to them. ✓
- Report any situation that is unsafe or unhealthy. ✓
- Report all incidents and accidents. ✓
- Do not interfere with any safety equipment or misuse such equipment. ✓
- Obey all safety rules. ✓ **(Any 1 x 1)** (1)

[10]

QUESTION 3: MATERIALS (GENERIC)

3.1 **Metal tests:**

3.1.1 **Filing test:**
Filing should be done on the tip or near the edge ✓ of the material to establish the relative hardness. ✓ (2)

3.1.2 **Machining test:**
This test is used on two unknown samples, identical in appearance and size, which is cut with a machine tool at the same speed and feed. ✓ The ease of cutting should be compared and the chips observed for heating colour and curl. ✓ (2)

3.2 **Sound test on the steel:**

3.2.1 **High carbon steel (Hard):**
Loud and clear ✓✓ (2)

3.2.2 **Low carbon steel (Soft):**
Dull sound ✓✓ (2)

3.3 **Heat treatment processes on steel:**

3.3.2 **Case hardening:**
To produce a hard case ✓ over a tough core. ✓ (2)

3.3.3 **Hardening:**
To enable the steel to resist wear ✓ and indentation ✓ (2)

3.3.5 **Normalising:**
To relieve ✓ the internal stress ✓ produced by machining. (2)
[14]

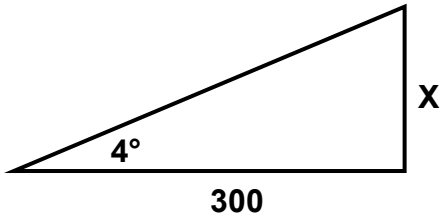
QUESTION 4: MULTIPLE-CHOICE QUESTIONS (SPECIFIC)

4.1	A ✓	(1)
4.2	D ✓	(1)
4.3	A ✓	(1)
4.4	C ✓	(1)
4.5	B ✓	(1)
4.6	B ✓	(1)
4.7	C ✓	(1)
4.8	A ✓	(1)
4.9	C ✓	(1)
4.10	B ✓	(1)
4.11	B ✓	(1)
4.12	B ✓	(1)
4.13	A ✓	(1)
4.14	A ✓	(1)

[14]

QUESTION 5: TERMINOLOGY (LATHE AND MILLING MACHINE) (SPECIFIC)

5.1 **Calculate the tailstock set-over:**



$$\text{Tan}\,\theta = \frac{X}{300} \quad \checkmark$$
$$x = \text{Tan}\,4° \times 300 \quad \checkmark$$
$$= 20{,}98 \text{ mm} \quad \checkmark$$

(3)

5.2 **Method to cut multiple-start threads:**

- Move the tool with the compound-slide ✓
- Turn the change-gears ✓
- Use a driving plate with accurately cut slots ✓
- Use a graduated driving plate ✓ **(Any 3 x 1)** (3)

5.3 **Parallel key:**

5.3.1 **Width:**

$$\text{Width} = \frac{D}{4}$$
$$= \frac{42}{4} \quad \checkmark$$
$$= 10{,}5 \text{ mm} \quad \checkmark$$

(2)

5.3.2 **Thickness:**

$$\text{Thickness} = \frac{D}{6}$$
$$= \frac{42}{6} \quad \checkmark$$
$$= 7 \text{ mm} \quad \checkmark$$

(2)

5.4 **Advantages of using the compound slide method to cut an external V-thread on the centre lathe:**

- Left side of the tool cuts the thread and the right side gives a smooth finish ✓
- The force on the tool is evenly distributed along the cutting edge ✓
- The cutting chips curl away from the thread ✓
- If the tool needs to be removed, the thread can easily be picked up again with the new tool ✓ **(Any 2 x 1)** (2)

5.5 **Advantages of down-cut milling:**

- Smooth cutting through thin pipes and tubes ✓
- Coolant is carried down to the teeth where it is required ✓
- Better finish is produced as chip is cut from maximum to minimum ✓
- Tends to force the work piece onto the machine table✓ **(Any 3 x 1)** (3)

5.6 **Factors that may be responsible for chatter marks on milling work:**

- Incorrect cutter for the process ✓
- A blunt cutter ✓
- Incorrect cutting speed ✓
- Incorrect feed tempo ✓
- Inadequate machine capacity for the process ✓ **(Any 3 x 1)** (3)

[18]

QUESTION 6: TERMINOLOGY (INDEXING) (SPECIFIC)

6.1 **Spur gear:**

6.1.1 **Number of teeth:**

$$\text{Module} = \frac{\text{PCD}}{\text{T}}$$

$$\text{Teeth} = \frac{\text{PCD}}{\text{m}} \quad ✓$$

$$= \frac{108}{3}$$

$$= 36 \text{ teeth} \quad ✓$$ (2)

6.1.2 **Outside diameter:**

$$\text{OD} = \text{PCD} + 2a$$

$$= 108 + 2(3)$$

$$= 114 \text{ mm}$$

or

$$= m(T + 2) \quad ✓$$

$$= 3(36 + 2)$$

$$= 114 \text{ mm} \quad ✓$$ (2)

6.1.3 **Cutting depth:**

$$\text{Cutting depth} = 2{,}157m$$

$$= 2{,}157 \times 3$$

$$= 6{,}47 \text{ mm}$$

or

$$= 2{,}25m \quad ✓$$

$$= 2{,}25 \times 3$$

$$= 6{,}75 \text{ mm} \quad ✓$$ (2)

6.1.4 **Addendum:**

$$\text{Addendum} = m$$

$$= 3 \text{ mm} \quad ✓$$ (1)

6.1.5 **Dedendum:**

$$\text{Dedendum} = 1{,}157m$$

$$= 1{,}157 \times 3$$

$$= 3{,}47 \text{ mm}$$

or

$$= 1{,}25m$$

$$= 1{,}25 \times 3$$

$$= 3{,}75 \text{ mm} \quad ✓$$ (1)

6.1.6 **Circular pitch:**

$$CP = m \times \pi \quad ✓$$

$$= 3 \times \pi$$

$$= 9{,}42 \text{ mm} \quad ✓$$ (2)

6.2 **Angular indexing:**

$$\text{Indexing} = \frac{n}{9^\circ} \quad \checkmark$$

$$= \frac{38}{9} \quad \checkmark$$

$$= 4\frac{2}{9} \times \frac{6}{6} \quad \checkmark$$

$$= 4\frac{12}{54} \quad \checkmark$$

4 full turns and 12 holes on the 54-hole circle ✓

(4)

6.3 **Differential indexing:**

$$\text{Indexing} = \frac{40}{N}$$

$$= \frac{40}{119} \quad \notin \text{ not possible}$$

$$= \frac{40}{A} \quad \checkmark$$

$$= \frac{40}{120} \div \frac{5}{5}$$

$$= \frac{8}{24} \quad \checkmark$$

✓

No full turns and 8 holes on a 24 hole circle

(Smallest value / Any other correct answer) ✓

$$\frac{Dr}{Dn} = \frac{A - N}{A} \times \frac{40}{1}$$

$$= \frac{120 - 119}{120} \times \frac{40}{1}$$

$$= \frac{1}{120} \times \frac{40}{1}$$

$$= \frac{40}{120} \quad \checkmark$$

$$= \frac{1}{3} \times \frac{24}{24} \quad \checkmark$$

$$\frac{Dr}{Dn} = \frac{24}{72}$$

(6)

6.4 **Calculate distance X across rollers:**

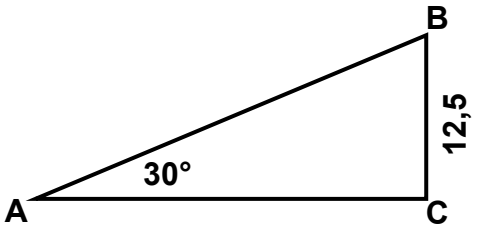
$$X = Y + 2(AC + r)$$

$$\text{Tan}\,\Theta = \frac{BC}{AC} \quad ✓$$

$$AC = \frac{BC}{\text{Tan}\,\Theta}$$

$$= \frac{12.5}{\text{Tan}\,30°} \quad ✓$$

$$= 21{,}65\ \text{mm}$$

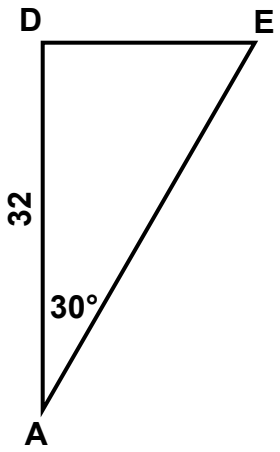


$$\text{Tan}\,30° = \frac{DE}{AD} \quad ✓$$

$$DE = \text{Tan}30° \times AD$$

$$= \text{Tan}30° \times 32$$

$$= 18{,}48\ \text{mm} \quad ✓$$



$$Y = 160 - 2(DE) \quad ✓$$

$$= 160 - 2(18{,}48)$$

$$= 160 - 36{,}96$$

$$Y = 123{,}04\ \text{mm} \quad ✓$$

$$X = Y + 2(AC + r) \quad ✓$$

$$= 123{,}04 + 2(21{,}65 + 12{,}5)$$

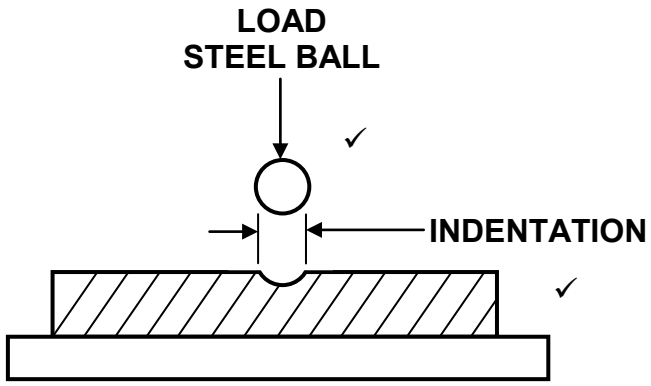
$$= 123{,}04 + 68{,}3$$

$$X = 191{,}34\ \text{mm} \quad ✓$$

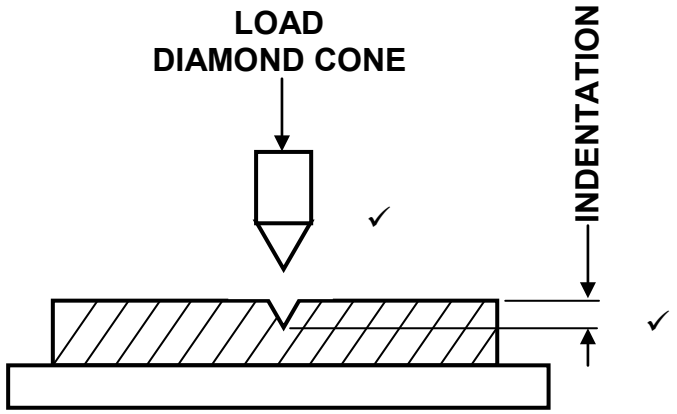
(8)
[28]

QUESTION 7: TOOLS AND EQUIPMENT (SPECIFIC)

7.1 **Brinell hardness tester:**



Rockwell hardness tester:



(4)

7.2 **Force tester:**
Apparatus to illustrate ✓ the concept of the triangle or parallelogram ✓ of forces. (2)

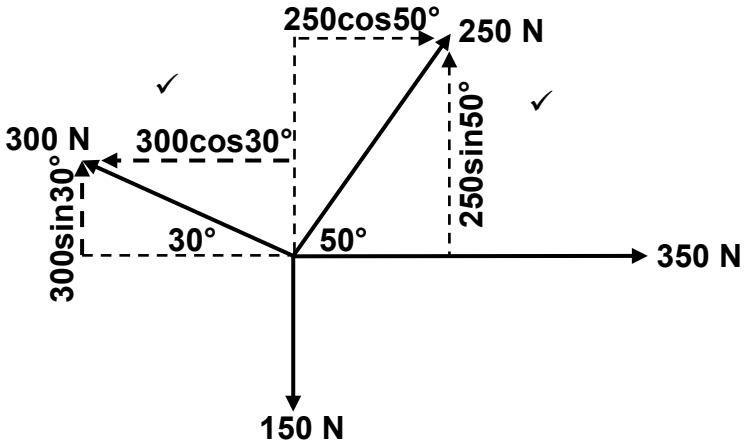
7.3 **Tensile tester:**
- Tensile strength ✓
- Elasticity ✓
- Ductility ✓
- Plasticity ✓ **(Any 2 x 1)** (2)

7.4 **Depth micrometer:**
50 ✓ + 16,00 + 0,5 ✓ + 0,11 = 66,61 mm ✓ (3)

7.5 Screw thread ✓ micrometer ✓ (2)
[13]

QUESTION 8: FORCES AND MOMENTS (SPECIFIC)

8.1 **Resultant:**



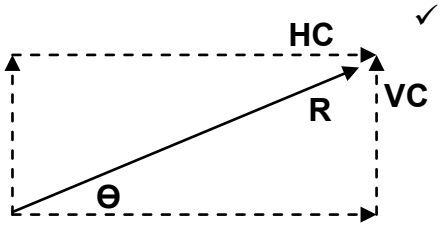
$$\sum HC = 350 + 250\cos 50° - 300\cos 30°$$
$$= 350 + 160,9 \checkmark - 259,81 \checkmark$$
$$= 251,16 \text{ N} \checkmark$$

$$\sum VC = 300\sin 30° + 250\sin 50° - 150$$
$$= 150 \checkmark + 191,51 \checkmark - 150$$
$$= 191,51\text{N} \checkmark$$

OR

Horizontal components	Magnitudes	Vertical components	Magnitudes
-300Cos30°	-259,81 N ✓	300Sin30°	150 N ✓
250Cos50°	160,97 N ✓	250Sin50°	191,51 N ✓
350	350 N	-150	-150 N
TOTAL	**251,16 N ✓**	**TOTAL**	**191,51 N ✓**

$$R^2 = HC^2 + VC^2$$
$$R = \sqrt{251,16^2 + 191,51^2}$$
$$R = 315,84\text{N} \checkmark$$

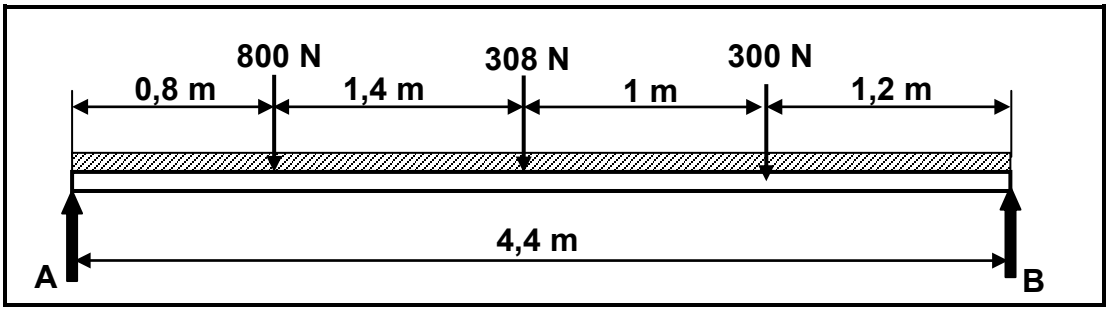


$$\text{Tan}\,\Phi = \frac{VC}{HC}$$
$$= \frac{191,51}{251,16}$$
$$\Phi = 37,33° \checkmark$$

$$R = 315,84\text{N} \checkmark \text{ at } 37,33° \checkmark \text{ north from east} \checkmark$$

(14)

8.2 **Moments:**



Single acting force:

$= 70\text{N/m} \times 4{,}4\text{m}$

$= 308\text{N}$ ✓

Calculate A.:
Moments about B.

$\sum \text{RHM} = \sum \text{LHM}$ ✓

$(A \times 4{,}4) = (300 \times 1{,}2) + (308 \times 2{,}2) + (800 \times 3{,}6)$ ✓

$\frac{4{,}4A}{4{,}4} = \frac{3917{,}60}{4{,}4}$

$A = 890{,}36\ \text{N}$ ✓

Calculate B:.
Moments about A.

$\sum \text{LHM} = \sum \text{RHM}$ ✓

$(B \times 4{,}4) = (800 \times 0{,}8) + (308 \times 2{,}2) + (300 \times 3{,}2)$ ✓

$\frac{4{,}4B}{4{,}4} = \frac{2277{,}60}{4{,}4}$

$A = 517{,}64\ \text{N}$ ✓ (7)

8.3 Stress and Strain:

8.3.1 Stress:

$$A = L^2 \quad \checkmark$$
$$= 0{,}025^2$$
$$A = 0{,}63 \times 10^{-3}\,m^2 \quad \checkmark$$

$$\sigma = \frac{F}{A} \quad \checkmark$$
$$= \frac{80 \times 10^3}{0{,}63 \times 10^{-3}} \quad \checkmark$$
$$\sigma = 126{,}98 \times 10^6 \text{ Pa}$$
$$\sigma = 126{,}98 \text{ MPa} \quad \checkmark$$

(5)

8.3.2 Strain:

$$E = \frac{\sigma}{\varepsilon} \quad \checkmark$$
$$\varepsilon = \frac{\sigma}{E} \quad \checkmark$$
$$= \frac{126{,}98 \times 10^6}{200 \times 10^9} \quad \checkmark$$
$$\varepsilon = 0{,}63 \times 10^{-3} \quad \checkmark$$

(4)

8.3.3 Safe working stress:

$$SF = \frac{\text{Break stress}}{\text{Safe working stress}}$$
$$\text{Safe working stress} = \frac{\text{Break stress}}{\text{Safety factor}} \quad \checkmark$$
$$= \frac{11 \times 10^6}{3} \quad \checkmark$$
$$= 3{,}67 \times 10^6 \text{ Pa}$$
$$= 3{,}67 \text{ MPa} \quad \checkmark$$

(3)
[33]

QUESTION 9: MAINTENANCE (SPECIFIC)

9.1 **Preventative maintenance:**

- Risk of injury or death ✓
- Financial loss due to damage suffered as a result of part failure ✓
- Loss of valuable production time ✓ (3)

9.2 **Malfunctioning of chain drives:**

- Lack of lubrication ✓
- Sprockets not properly secured to shafts ✓
- Incorrect sprocket alignment ✓
- Overloading ✓
- Incorrect tension ✓ **(Any 2 x 1)** (2)

9.3 **Wear on a belt drive system:**

- Check for wear and tear ✓
- Check belt/pulley alignment ✓
- Check tension setting ✓
- Check tensioning devices, e.g. jockeys ✓ **(Any 2 x 1)** (2)

9.4 **Replace the belt on a belt drive system:**

- Release the tension on the belt and remove from pulleys ✓
- Check the condition and alignment of the pulleys ✓
- Fit the new specified belt ✓
- Apply adequate tension to the belt ✓
- Check for proper operation ✓ (5)

9.5 **Materials**

9.5.1 **Polyvinyl chloride (PVC):**

- It is a thermoplastic composite ✓
- Flexible ✓
- Gives a dull sound ✓
- It is a tough material ✓
- It can be welded or bonded with an adhesive ✓
- Good electrical insulation ✓ **(Any 1 x 1)** (1)

9.5.2 **Carbon fibre:**

- It is a thermo hardened (thermosetting) composite ✓
- It is a strong and tough material ✓
- It is a light weight material ✓
- It is water resistant ✓
- It is UV resistant ✓
- It is a good electrical insulation ✓ **(Any 1 x 1)** (1)

9.6 **Thermoplastic or Thermo hardened composites:**

9.6.1 **Teflon:**
Thermoplastic ✓ (1)

9.6.2 **Vesconite:**
Thermoplastic ✓ (1)

9.6.3 **Bakelite:**
Thermo hardened ✓ (1)

9.7 **Coefficient of friction:**
Thermo composites ✓ (1)
[18]

QUESTION 10: JOINING METHODS (SPECIFIC)

10.1 **Square screw thread:**

10.1.1 **Screw thread lead:**

$$\text{Lead} = \text{pitch} \times \text{no of starts} \quad ✓$$
$$= 7 \times 3$$
$$= 21\text{mm} \quad ✓$$

(2)

10.1.2 **Helix angle:**

$$\text{Mean circumference} = \pi\left(\text{OD} - \frac{P}{2}\right) \quad ✓$$
$$= \pi\left(90 - \frac{7}{2}\right) \quad ✓$$
$$= 271{,}75\,\text{mm} \quad ✓$$

$$\text{Helix angle } \tan\Phi = \frac{\text{lead}}{\text{pitch diameter}} \quad ✓$$
$$= \frac{21}{271{,}75} \quad ✓$$
$$= 0{,}07727$$
$$\Phi = 4°25' \quad ✓$$

(6)

10.1.3 **Leading angle:**

$$\text{Leading tool angle} = 90° - (\text{helix angle} + \text{clearance angle}) \quad ✓$$
$$= 90° - (4°25' + 3°)$$
$$= 82°35' \quad ✓$$

(2)

10.1.4 **Following angle:**

$$\text{Following tool angle} = 90° + (\text{helix angle} - \text{clearance angle}) \quad ✓$$
$$= 90° + (4°25' - 3°)$$
$$= 91°25' \quad ✓$$

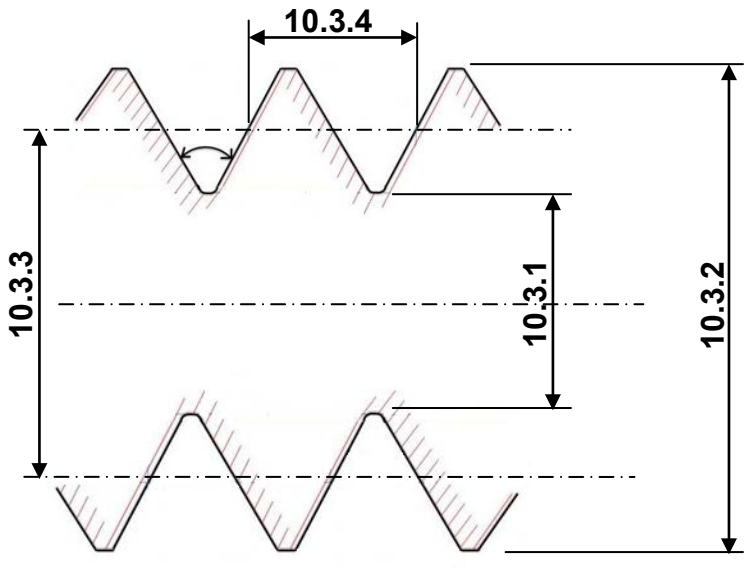
(2)

10.2 **Diameter of drill:**

$$\text{Diameter of drill} = \text{Outside dia} - \text{pitch} \quad ✓$$
$$= 16 - 2$$
$$= 14\text{mm} \quad ✓$$

(2)

10.3 **V-screw thread:**



10.3.1 Root diameter ✓ (1)

10.3.2 Crest diameter ✓ (1)

10.3.3 Effective diameter ✓ (1)

10.3.4 Pitch ✓ (1)

[18]

QUESTION 11: SYSTEMS AND CONTROL (DRIVE SYSTEMS) (SPECIFIC)

11.1 **Advantages of a belt drive:**

- Needs no lubrication ✓
- Silent operation ✓
- Cheaper parts ✓
- Can change direction without additional components ✓
- Easy to replace ✓
- Transmit power over a longer distance ✓ **(Any 3 x 1)** (3)

11.2 **Hydraulics:**

$$A = \frac{\pi D^2}{4} \quad \checkmark$$

$$= \frac{\pi(0,12)^2}{4} \quad \checkmark$$

$$A = 11,31\times10^{-3}\,m^2 \quad \checkmark$$

$$p = \frac{F}{A} \quad \checkmark$$

$$F = p \times A \quad \checkmark$$

$$F = \left(1,2\times10^{6}\right)\times\left(11,31\times10^{-3}\right) \quad \checkmark$$

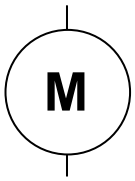
$$F = 13572\ N$$

$$F = 13,57\ kN \quad \checkmark$$

(7)

11.3 **Hydraulic symbols:**

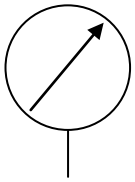
11.3.1 **Electrical motor:**



✓
✓

(2)

11.3.2 **Pressure gauge:**



✓
✓

(2)

11.4 **Belt-drive system:**

11.4.1 **Belt speed:**

$$v = \frac{\pi DN}{1000 \times 60} \quad \checkmark$$

$$= \frac{\pi \times 230 \times 1440}{1000 \times 60} \quad \checkmark$$

$$v = 17{,}34 \text{ m.s}^{-1} \quad \checkmark$$

(3)

11.4.2 **Power transmitted:**

$$P = (T_1 - T_2)v \quad \checkmark$$

$$= 165 \times 17{,}34 \quad \checkmark$$

$$P = 2861{,}10 \text{ Watt}$$

$$P = 2{,}86 \text{ kW} \quad \checkmark$$

(3)

11.5 **Gear drive system:**

11.5.1 Driven gear C will rotate in the same direction (clockwise) ✓ (1)

11.5.2 **Number of teeth on gear C:**

$$T_C \times N_C = T_A \times N_A \quad \checkmark$$

$$T_C = \frac{T_A \times N_A}{N_C} \quad \checkmark$$

$$= \frac{102 \times 120}{80} \quad \checkmark$$

$$T_C = 153 \text{ teeth} \quad \checkmark$$

(4)

11.6 **Chain drive system:**

Gear ratio:

$$GR = \frac{T_{dr}}{T_{dn}} \quad \checkmark$$

$$= \frac{48}{32} \quad \checkmark$$

$$GR = 1:1{,}5 \quad \checkmark$$

OR

$$GR = \frac{T_{dn}}{T_{dr}} \quad \checkmark$$

$$= \frac{32}{48} \quad \checkmark$$

$$GR = 1:0{,}67 \quad \checkmark$$

(3)

[28]

TOTAL: 200