basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

**NATIONAL
SENIOR CERTIFICATE**

GRADE 12

MECHANICAL TECHNOLOGY: FITTING AND MACHINING

NOVEMBER 2022

MARKING GUIDELINES

MARKS: 200

These marking guidelines consist of 23 pages.

M. BRIJLALL IM
11/12/2022

JDJ Bosman.
11/12/2022

MBULE T.J
11/12/2022

P. Naidoo
11/12/2022

11/12/2022

QUESTION 1: MULTIPLE-CHOICE QUESTIONS (GENERIC)

1.1   B ✓ (1)

1.2   B ✓ (1)

1.3   C ✓ (1)

1.4   C ✓ (1)

1.5   A ✓ (1)

1.6   B ✓ (1)
[6]

QUESTION 2: SAFETY (GENERIC)

2.1 **Vital functions:**
- Breathing ✓
- Heart rate / pulse ✓
- State of consciousness ✓

(Any 2 x 1)   (2)

2.2 **Safety glasses during grinding:**
- To prevent any injuries to the operator's eyes. ✓
- To protect eyes from sparks and debris. ✓
- To prevent blindness due to injury. ✓

(Any 1 x 1)   (1)

2.3 **Type of guards:**
- Fixed guard ✓
- Automatic sweep-away ✓
- Self-adjusting / automatic guard ✓
- Electronic presence sensing device ✓
- Two-hand control device. ✓

(Any 2 x 1)   (2)

2.4 **Precautions *before* gas welding operations can be undertaken:**
- An operator has been instructed on how to use the equipment safely. ✓
- A workplace is effectively partitioned off. ✓
- An operator uses protective equipment (PPE). ✓
- Ensure that fire equipment is at hand. ✓
- Ensure that the equipment is in a safe working condition. ✓
- Ensure the gas equipment is set-up correctly. ✓
- Ensure the area is well ventilated. ✓
- Ensure that the working area is safe. ✓

(Any 3 x 1)   (3)

2.5 **TWO disadvantages of the product layout:**
- Lack of flexibility. ✓
- Optimum use of equipment is not possible. ✓

(2)
[10]

QUESTION 3: MATERIALS (GENERIC)

3.1   **THREE properties:**
- Toughness ✓
- Hardness / Wear resistance ✓
- Softness ✓
- Case hardness ✓
- Ductility ✓
- Malleability ✓
- Elasticity ✓
- Brittleness ✓
- Strength ✓

(Any 3 x 1)   (3)

3.2   **Heat treatment processes:**

3.2.1   **Tempering:**
- It consists of heating the hardened steel ✓ to a temperature below its critical temperature (colour chart). ✓
- Soaking it at this temperature for a period of time, ✓
- Quenching/cooling it rapidly in water, brine or oil. ✓   (4)

3.2.2   **Hardening:**
- The steel is heated slightly higher than the upper critical temperature. ✓
- The steel is soaked at that temperature for the required time. ✓
- The steel is then rapidly cooled by quenching in water, brine or oil. ✓   (3)

3.3   **Examples of case-hardening:**
- Bearing cases ✓
- Bearing ball ✓
- Bearing needles ✓
- Crankshafts ✓
- Gears ✓
- Camshafts ✓
- Cylinder sleeves ✓
- Hammer head ✓
- Jack Hammer drill bits ✓

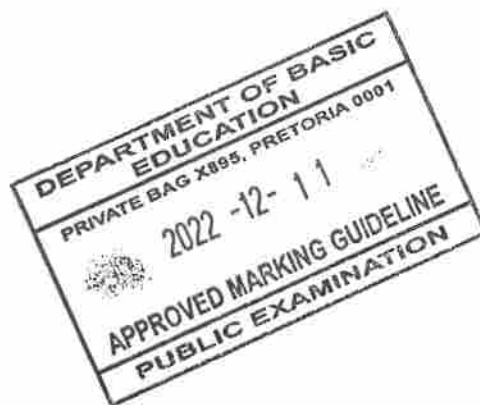**(Any 2 x 1)**   (2)

3.4   **Why steels are cooled down in still air away from draughts:**
This prevents sudden cooling of localised spots, ✓ which might cause distortion/cracks. ✓   (2)

[14]

QUESTION 4: MULTIPLE-CHOICE QUESTIONS (SPECIFIC)

4.1   C ✓   (1)

4.2   A ✓   (1)

4.3   B ✓   (1)

4.4   D ✓   (1)

4.5   C ✓   (1)

4.6   A ✓   (1)

4.7   B ✓   (1)

4.8   B ✓   (1)

4.9   C ✓   (1)

4.10   A ✓   (1)

4.11   B ✓   (1)

4.12   A ✓   (1)

4.13   D ✓   (1)

4.14   D ✓   (1)

[14]

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

5.1   **TWO advantages of cutting using the tailstock set-over method:**
- Long tapers can be cut. ✓
- The automatic feed can be used. ✓
- Good finish is obtained ✓

                                                    (Any 2 x 1)   (2)

5.2   **Big diameter of taper:**

$$\tan\frac{\theta}{2}=\frac{D-d}{2\times l}$$

$$D=\text{Tan}\frac{\theta}{2}(2\times l)+d \quad ✓$$

$$=\text{Tan}\frac{8°}{2}(2\times 290)+42 \quad ✓$$

$$=\text{Tan}4°(580)+42 \quad ✓$$

$$D=82{,}56 \text{ mm} \quad ✓$$

         (4)

5.3   **Calculation of parallel key:**

5.3.1
$$\text{Width}=\frac{D}{4}$$

$$=\frac{65}{4} \quad ✓$$

$$=16{,}25 \text{ mm} \quad ✓$$

         (2)

5.3.2
$$\text{Thickness}=\frac{D}{6}$$

$$=\frac{65}{6} \quad ✓$$

$$=10{,}83 \text{ mm} \quad ✓$$

         (2)

5.3.3 $\text{Length}=1{,}5\times \text{diameter of shaft}$
$$=1{,}5\times 65 \quad ✓$$
$$=97{,}5 \text{ mm} \quad ✓$$

         (2)

5.4   **Disadvantages of straddle milling:**
- The cutters used place more stress on the machine's spindle. ✓
- The milling machine works harder due to more than one cutter being used. ✓
- There can be more vibration. ✓
- Poor finishing. ✓

                                                         (Any 1 x 1)   (1)

5.5   **TWO milling processes:**

        The milling of:
- Bevels ✓
- Keyways ✓
- Slides ✓
- Chamfers ✓
- Other angles ✓
- Grooves ✓
- Jigs recesses ✓
- Tees ✓
- Dovetail slots ✓
- Surface milling ✓
- Drilling ✓
- Reaming ✓
- Tapping ✓
- Up-cut milling ✓
- Down-cut milling ✓

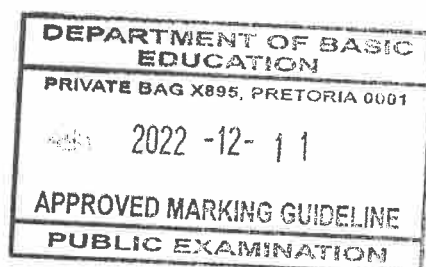   **(Any 2 x 1)**   (2)

5.6   **Calculate X:**

$$x = \frac{\text{Diameter of workpiece} - \text{Thickness of cutter}}{2} \quad ✓$$

$$= \frac{60 - 12}{2} \quad ✓$$

$$= \frac{48}{2}$$

$$= 24\,\text{mm} \quad ✓$$

                                                               (3)
                                                              [18]

QUESTION 6: TERMINOLOGY (INDEXING) (SPECIFIC)

6.1 **Gear calculations:**

6.1.1 **Module:**

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

$$= \frac{165}{110} \checkmark$$

$$= 1,5 \checkmark$$

(2)

6.1.2 **Outside diameter:**

OD = PCD +2(m)   OD = m(T + 2)
    = 165 + 2(1,5) $\checkmark$ **OR**   = 1,5(110 + 2) $\checkmark$
    = 168 mm $\checkmark$ = 168 mm $\checkmark$

(2)

6.2 **Dovetail calculations:**
W = 120 + 2(DE)
m = W − [2(AC) + 2(R)] **OR** m = W − 2(AC + R) **OR** m = W − 2(AC) − 2(R)

6.2.1 **Maximum width distance of dove tail. (W)**

Calculate DE:

$$\text{Tan}\,\alpha = \frac{DE}{AD} \qquad\qquad \text{Tan}\,\theta = \frac{AD}{DE}$$

DE = $\tan\alpha \times AD$ $\checkmark$ DE = $\dfrac{AD}{\text{Tan}60°}$ $\checkmark$

                                OR

= $\tan30° \times 30$ $\checkmark$ = $\dfrac{30}{\text{Tan}60°}$ $\checkmark$

= 17,32mm $\checkmark$ =17,32mm $\checkmark$

W = 120 + 2(DE) $\checkmark$
   = 120 + 2(17,32) $\checkmark$
   = 120 + 34,64
   = 154,64 mm $\checkmark$

(6)
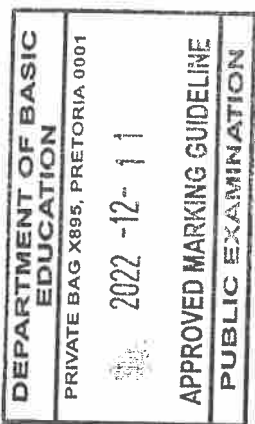
6.2.2　**Distance between the rollers. (m)**

Calculate AC:

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

$$AC = \frac{BC}{\text{Tan}\,\alpha} \checkmark$$

OR

$$= \frac{11}{\text{Tan}30°} \checkmark$$

$$= 19,05\,\text{mm} \checkmark$$

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

$$AC = \text{Tan}\,\theta \times BC \checkmark$$

$$= \text{Tan}60° \times 11 \checkmark$$

$$= 19,05\,\text{mm} \checkmark$$

m = W – [(2(AC) + 2(R)] $\checkmark$

　= 154,64 – [2(19,05) + 2(11)] $\checkmark$

　= 154,64 – (38,10 + 22)

　= 94,54 mm $\checkmark$

OR

m = W – 2(AC + R) $\checkmark$

　= 154,64 – 2(19,05 + 11) $\checkmark$

　= 154,64 – (38,10 + 22)

　= 94,54 mm $\checkmark$

OR

m = W – 2(AC) – 2(R) $\checkmark$

　= 154,64 – 2(19,05) – 2(11) $\checkmark$

　= 154,64 – 38,11 – 22

　= 94,54 mm $\checkmark$

(6)

6.3　　　**Milling of spur gear:**

　　6.3.1　　**Indexing:**

$$\text{Indexing} = \frac{40}{n} = \frac{40}{163}$$

$$= \frac{40}{A} = \frac{40}{160} \checkmark$$

$$= \frac{1}{4} \times \frac{6}{6}$$

$$= \frac{6}{24} \checkmark$$

Approximate indexing: 6 holes on a 24-hole circle. ✓

OR

7 holes on a 28-hole circle. ✓

(3)

　　6.3.2　　**Change gears:**

$$\frac{Dr}{Dn} = (A-n) \times \frac{40}{A}$$

$$= (160-163) \times \frac{40}{160} \checkmark$$

$$= -3 \times \frac{40}{160} \checkmark$$

$$= \frac{-120}{160}$$

$$= \frac{12}{16} \times \frac{2}{2} \checkmark \quad \textbf{OR} \quad \frac{12}{16} \times \frac{4}{4} \checkmark$$

$$= \frac{24 \checkmark}{32 \checkmark} \quad \textbf{OR} \quad \frac{48 \checkmark}{64 \checkmark}$$

(5)
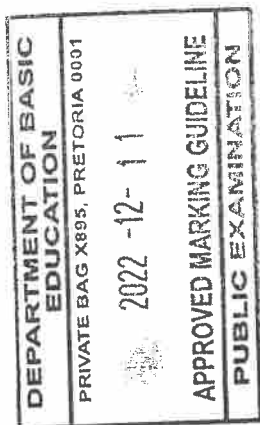
6.4   **TWO types of balancing methods:**
- Static balance (stationary balancing) ✓
- Dynamic balance (running balancing) ✓   (2)

6.5   **TWO advantages of correct balancing:**
- Prevents vibrations. ✓
- Prevents poor finish / ensure good finish. ✓
- Prevents wear on bearings / components. ✓
- Prevents accidents. ✓
- Improve production. ✓
- Promotes accuracy. ✓
- Prevent damage to workpiece. ✓
- Prevent components from loosening. ✓

         (Any 2 x 1)   (2)
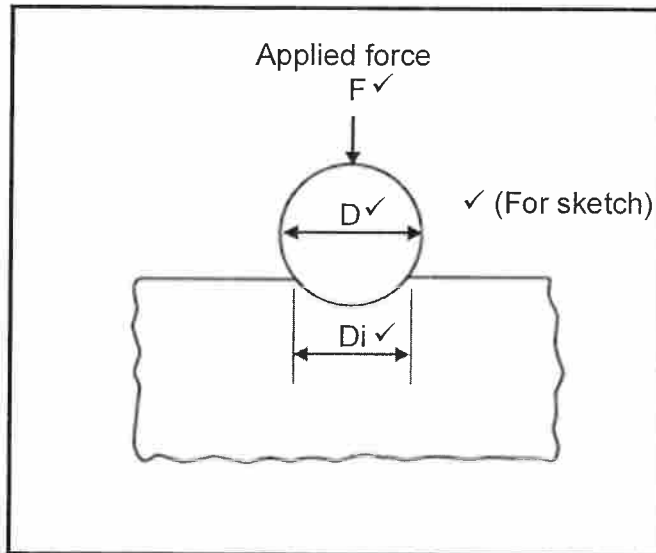   **[28]**

QUESTION 7: TOOLS AND EQUIPMENT (SPECIFIC)

7.1   **Function of a screw-thread micrometer:**
        The screw-thread micrometer is specifically designed to measure ✓ the pitch
        diameter ✓ of a screw thread.   (2)

7.2   **Brinell labelled drawing:**

Applied force
F ✓

D ✓   ✓ (For sketch)

Di ✓

Di - Indentation

D - Indenter diameter

(4)

7.3   **Types of forces:**
        • Tensile force ✓
        • Compressive force ✓
        • Shear force ✓
        • Torsional force ✓
        • Gravitational force ✓
        • Normal Force ✓
        • Frictional Force ✓
        • Reaction Force ✓

                                                        (Any 2 x 1)   (2)

7.4   **ISO-Metric screw-thread:**

        7.4.1   A – Root/Root land ✓
                  B – Pitch diameter / Effective diameter / Mean diameter ✓
                  C – Crest diameter / Major diameter / Outside diameter / Basic
                      diameter ✓   (3)

        7.4.2   **Pitch diameter:**
                  $Dp = Dn - (0,866 \times P)$

                  $Dp = 12 - (0,866 \times 1,75)$ ✓

                  $Dp = 12 - 1,52$

                  $Dp = 10,48$ mm ✓   (2)

                                                                                [13]
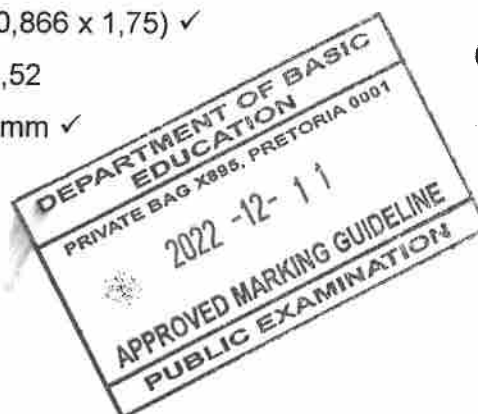
QUESTION 8: FORCES (SPECIFIC)

8.1   **Forces:**

8.1.1   **Horizontal component:**

$$\Sigma HC = 25\cos90° + 40\cos0° + 55\cos70° - 120\cos30°$$

$$\Sigma HC = 0 + \overset{\checkmark}{40} + \overset{\checkmark}{18,81} - \overset{\checkmark}{103,92}$$

$$\Sigma HC = -45,11N \checkmark$$ (4)

8.1.2   **Vertical component:**

$$\Sigma VC = 25\sin90° - 40\sin0° - 55\sin70° - 120\sin30°$$

$$\Sigma VC = \overset{\checkmark}{25} - 0 - \overset{\checkmark}{51,68} - \overset{\checkmark}{60}$$

$$\Sigma VC = -86,68N \checkmark$$ (4)

OR

Force	θ	8.1.1 $\Sigma HC/x = F\cos\theta$		8.1.2 $\Sigma VC/y = F\sin\theta$	
25N	90°	HC = 25cos90°	0N	VC = 25sin90°	25N ✓
40N	0°	HC = 40cos0°	40N ✓	VC = 40sin0°	0N
55N	290°	HC = 55cos290°	18,81N ✓	VC = 55sin290°	-51,68N ✓
120N	210°	HC = 120cos210°	-103,92N ✓	VC = 120sin210°	-60N ✓
		Total	**-45,11N ✓**		**-86,68N ✓**

(8)

8.1.3   **Resultant:**

$$R^2 = VC^2 + HC^2$$
$$R = \sqrt{(-86,68)^2 + (-45,11)^2}   \checkmark$$
$$R = \sqrt{9549,24}$$
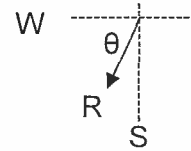$$R = 97,72N   \checkmark$$ (2)

8.1.4   **Angle and direction of resultant:**
Angle:

$$\tan\theta = \frac{VC}{HC}$$

$$\theta = \tan^{-1}\left(\frac{-86,68}{-45,11}\right) \checkmark$$

$$\theta = \tan^{-1}(1,92)$$

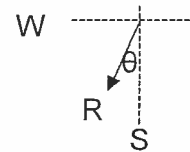$$\theta = 62,5° \checkmark$$

W ┄┄┄╆┄┄┄
     θ╱┊
R ↙┊
    S

OR

$$\tan\theta = \frac{HC}{VC}$$

$$\theta = \tan^{-1}\left(\frac{-45,11}{-86,68}\right) \checkmark$$

$$\theta = \tan^{-1}(0,52)$$

$$\theta = 27,49° \checkmark$$

W ┄┄┄╆┄┄┄
     ╱θ┊
R ↙┊
    S

Direction:
R = 97,72N   62,5°South of West $\checkmark$
OR
R = 97,72N 27,5° West of South $\checkmark$ (3)

8.2   **UDL Beam:**

8.2.1   **Distributed load:**
Uniform distributed load:
7 x 12 = 84 N $\checkmark$ (1)

8.2.2   **Reaction in support A:**
Take moments about B:

$$\overset{\checkmark}{(75\times12,5)} + \overset{\checkmark}{(84\times5,5)} + \overset{\checkmark}{(55\times0)} = (A\times14)$$

$$937,5 + 462 + 0 = 14A$$

$$A = \frac{1399,5}{14} \quad \checkmark$$

$$A = 99,96\,N \quad \checkmark \qquad (5)$$

8.2.3   **Reaction in support B:**
Take moments about A:

$$(B \times 14) = (75 \times 1,5) + (84 \times 8,5) + (55 \times 14)$$

$$14B = 112,5 + 714 + 770$$

$$B = \frac{1596,5}{14}$$

$$B = 114,04\,N$$

(5)

8.3.1   **Resistance area:**

$$\sigma = \frac{F}{A}$$

$$A = \frac{F}{\sigma}$$

$$A = \frac{85 \times 10^3}{36 \times 10^6}$$

$$A = 2,36 \times 10^{-3}\,m^2$$

(3)

8.3.2   **Change in length:**

$$E = \frac{\sigma}{\varepsilon}$$

$$\varepsilon = \frac{\sigma}{E}$$

$$\varepsilon = \frac{36 \times 10^6}{90 \times 10^9}$$

$$\varepsilon = 4 \times 10^{-4}$$

$$\varepsilon = \frac{\Delta L}{L}$$

$$\Delta L = \varepsilon \times L$$

$$\Delta L = 4 \times 10^{-4} \times 0,12$$

$$\Delta L = 4,8 \times 10^{-5}\,m$$

$$\Delta L = (4,8 \times 10^{-5}) \times 1000$$

$$\Delta L = 0,048\ mm$$

(6)
[33]

QUESTION 9: MAINTENANCE (SPECIFIC)

9.1   **Failure to conduct preventative maintenance:**
- Risk of injury or death. ✓
- Financial loss due to damage suffered as a result of part failure. ✓
- Loss of valuable production time. ✓
- Equipment failure. ✓
- Damage to material or project. ✓

                                                              (Any 3 x 1)   **(3)**

9.2   **Mechanical drives:**
- Belt drives ✓
- Gear drives ✓
- Chain drives ✓
- Hydrostatic drives ✓
- Hydraulic drives ✓
- Cable drives ✓
- Pneumatic drive ✓

                                                              (Any 3 x 1)   **(3)**

9.3   **Enhance the strength of glass fibre:**
Polyester resin ✓

                                                                (1)

9.4   **Properties:**
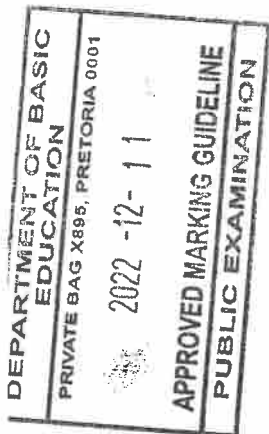   9.4.1   **Bakelite:**
- Stiff ✓
- Strong ✓
- Hard / wear resistant ✓
- Chemical resistance ✓
- Thermo hardened ✓
- Water resistant ✓
- Electrical isolation ✓
- Heat resistant ✓
- Machinable ✓
- Brittleness ✓

                                                               (Any 2 x 1)   **(2)**

      9.4.2   **Carbon fibre:**
- Good fatigue resistance ✓
- Heat resistance ✓
- Tough ✓
- Strong ✓
- Semi rigid ✓
- Good chemical resistance ✓
- Light weight ✓
- Water resistant ✓
- Flexible ✓

                                                               (Any 2 x 1)   **(2)**

9.5   **Manufacturing of PVC:**
- Oil ✓
- Salt ✓
- Coal ✓

                                                       (Any 1 x 1)   (1)

9.6   **Ways to conduct preventive maintenance:**
- Inspection ✓
- Measuring ✓
- Cleaning ✓
- Lubricating ✓
- Adjusting of parts ✓
- Replacing of parts ✓
- Tests ✓

                                                        (Any 3 x 1)   (3)

9.7   **Main types of plastic composites:**
- Thermoplastic ✓
- Thermosetting plastic / Thermo-hardened ✓   (2)

9.8   **Non-stick coatings for frying pans:**
Teflon ✓   (1)

                                                                [18]

QUESTION 10: JOINING METHODS (SPECIFIC)

10.1   **Screw thread terminology:**

    10.1.1   **Lead:**
                It is the distance ✓ that the point (nut/bolt) on a screw thread will move / advance ✓ along the axis, ✓ when turned through one complete revolution / turn. ✓   (4)

    10.1.2   **Helix angle:**
                It is the angle that the thread makes with a line perpendicular / 90° ✓ to the axis of the screw thread. ✓   (2)

10.2   **Square Thread:**

    10.2.1   **Pitch:**

$$\text{Lead} = \text{Pitch} \times \text{Number of starts}$$

$$\text{Pitch} = \frac{\text{Lead}}{\text{Number of starts}} \quad ✓$$

$$= \frac{42}{2} \quad ✓$$

$$= 21 \text{ mm} \quad ✓$$
          (3)
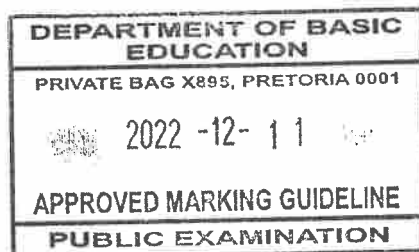
    10.2.2   **Pitch diameter:**

$$PD = OD - \frac{P}{2}$$

$$= 90 - \frac{21}{2} \quad ✓$$

$$= 79{,}50 \text{ mm} \quad ✓$$
          (2)

10.2.3 **Helix angle of the thread:**

$$\tan\theta = \frac{\text{Lead}}{\pi \times D_m}$$

$$\tan\theta = \frac{42 \;\checkmark}{\pi \times 79{,}50 \;\checkmark}$$

$\tan\theta = 0{,}168163713$

$\theta = \tan^{-1} 0{,}168163713$

$\quad\quad = 9{,}55° \text{ or } 9° \, 33' \;\checkmark$ (3)

10.2.4 **Leading tool angle:**

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

$\quad\quad\quad\quad = 90° - (9{,}55° + 3°) \;\checkmark$

$\quad\quad\quad\quad = 77{,}45° \text{ or } 77° \, 27' \;\checkmark$ (2)

10.2.5 **Following tool angle:**
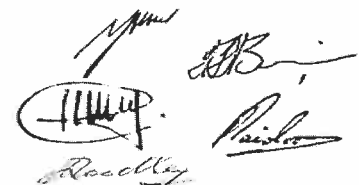
Following tool angle = 90° + (helix angle - clearance angle)

$\quad\quad\quad\quad = 90° + (9{,}55° - 3°) \;\checkmark$

$\quad\quad\quad\quad = 96{,}55° \text{ or } 96° \, 33' \checkmark$ (2)

[18]

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

11.1   **Hydraulic calculations :**

11.1.1   **The fluid pressure in the hydraulic system in MPa:**

$$A\left(Ram\right) = \frac{\pi d^2}{4}$$

$$A = \frac{\pi(0,25)^2}{4} \quad \checkmark$$

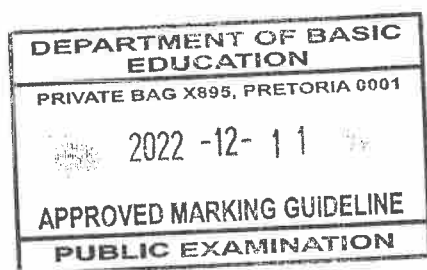$$A = 0,049 \, m^2 \quad OR \quad 4,91 \times 10^{-2} \, m^2 \quad \checkmark$$

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

$$p = \frac{34000}{0,049} \quad \checkmark$$

$$p = 693877,55 \, Pa$$

$$p = 0,69 \, MPa \quad \checkmark$$

(4)

11.1.2 Diameter of the plunger:

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

$$\frac{F_1}{A_1} = \frac{F_2}{A_2}$$

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

$$\frac{F_1}{\frac{\pi d^2}{4}} = \frac{F_2}{\frac{\pi D^2}{4}}$$

$$A = \frac{215}{693877,55} \checkmark$$

$$A = 0,309852 \times 10^{-3} \text{ m}^2 \checkmark \quad \textbf{OR}$$

$$\frac{215}{d^2} \checkmark = \frac{34000}{250^2} \checkmark$$

$$A = \frac{\pi d^2}{4}$$

$$d^2 \times 34000 = 215 \times 250^2 \checkmark$$

$$d = \sqrt{\frac{4 \times A}{\pi}} \checkmark$$

$$d = \sqrt{\frac{4\left(0,309852 \times 10^{-3}\right)}{\pi}} \checkmark$$

$$d = \sqrt{\frac{215 \times 250^2}{34000}} \checkmark$$

$$d = 0,019862422 \text{ m}$$

$$d = 19,86 \text{ mm} \checkmark$$

$$d = 19,88 \text{ mm} \checkmark$$

(5)

11.2 Hydraulic filters:
- Pressure line filter $\checkmark$
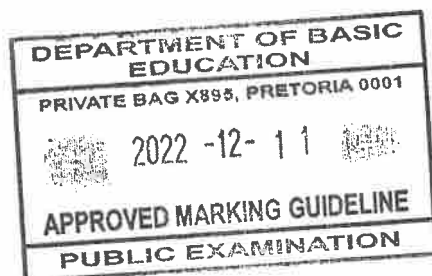- Return line filter $\checkmark$

(2)

11.3 Hydraulic symbols:

11.3.1 Reservoir $\checkmark$ (1)

11.3.2 Directional control valve / Non-return valve / One way valve $\checkmark$ (1)

11.4 **Belt drive:**

11.4.1 **The rotational frequency in r/sec:**

$$N_{Dr} \times D_{Dr} = N_{Dn} \times D_{Dn}$$

$$N_{Dn} = \frac{N_{Dr} \times D_{Dr}}{D_{Dn}} \checkmark$$

$$N_{Dn} = \frac{1330 \times 0,15}{0,32} \checkmark$$

$$N_{Dn} = \frac{623,44 \ r/min}{60}$$

$$N_{Dn} = 10,39 \ r/sec \checkmark$$

(3)

11.4.2 **Power transmitted in Watt:**

$$P = \frac{(T_1 - T_2)\pi DN}{60}$$

$$P = (175 \overset{\checkmark}{-} 130)\pi \times 0,3\overset{\checkmark}{2} \times 10,\overset{\checkmark}{39}$$

$$P = 470,03 \ Watt \checkmark$$

OR

$$P = \frac{(T_1 - T_2)\pi DN}{60}$$

$$P = \frac{(175 \overset{\checkmark}{-} 130)\pi \times 0,15 \overset{\checkmark}{\times} 1330 \overset{\checkmark}{}}{60}$$

$$P = 470,06 \ Watt \checkmark$$

(4)
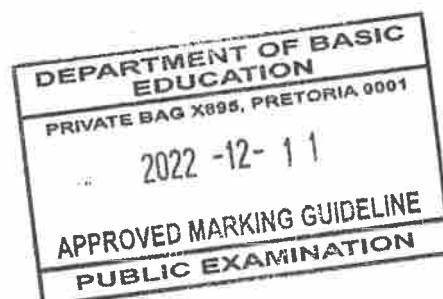
11.5   **Gear drive:**

11.5.1   **Identify gear drive:**
Compound gear drives system ✓   (1)

11.5.2   **Rotational frequency of the input shaft N_A:**

$$\frac{N_{input}}{N_{output}} = \frac{\text{Product of teeth on driven gears}}{\text{Product of teeth on driver gears}}$$

$$\frac{N_A}{N_F} = \frac{T_B \times T_D \times T_F}{T_A \times T_C \times T_E} \quad ✓$$

$$\frac{N_A}{625} = \frac{40 \times 50 \times 80 \; ✓}{20 \times 35 \times 25 \; ✓}$$

$$N_A = \frac{40 \times 50 \times 80 \times 625}{20 \times 35 \times 25}$$

$$N_A = 5714,29 \; r\,/\,min \quad ✓$$ (4)

11.6   **Torque on the lathe spindle:**

$$\text{Torque}\,(T) = \text{Force} \times \text{Radius}$$

$$T = 250 \times 0,025$$
$\qquad\quad ✓ \qquad ✓$

$$T = 6,25 \; Nm. \quad ✓$$ (3)
                                                                                [28]

                                                            TOTAL: 200