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Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

MECHANICAL TECHNOLOGY: FITTING AND MACHINING

NOVEMBER 2024

MARKING GUIDELINES

MARKS: 200

These marking guidelines consist of 23 pages.

QUESTION 1: MULTIPLE-CHOICE (GENERIC)

| | | |
|-----|-----|------------|
| 1.1 | A ✓ | (1) |
| 1.2 | D ✓ | (1) |
| 1.3 | A ✓ | (1) |
| 1.4 | B ✓ | (1) |
| 1.5 | D ✓ | (1) |
| 1.6 | C ✓ | (1) |
| | | [6] |

QUESTION 2: SAFETY (GENERIC)**2.1 Horizontal band saw (Already been switched on):**

- Never leave the band saw unattended while in motion. ✓
- Switch off the band saw when leaving. ✓
- Use a brush or wooden rod to remove chips/swarf/filings. ✓
- When reaching around a revolving band saw, be careful that your clothes do not get caught in the blade. ✓
- Don't stop a revolving bandsaw blade with your hand. ✓
- Don't adjust the band saw while working. ✓
- Don't open any guard while in motion. ✓
- Keep hands away from action points. ✓
- Do not force the band saw blade into the material. ✓
- Apply cutting fluid if required. ✓
- Avoid overcrowding of persons around the machine. ✓
- Do not lean on the machine. ✓
- Check if the machine is running smoothly. ✓

(Any 2 x 1) (2)**2.2 First aid basic treatment:**

- Examination ✓
- Diagnosis ✓
- Treatment ✓

(3)**2.3 Oxygen fittings with oil and grease:**

It forms a flammable mixture. ✓

(1)**2.4 Disadvantages of the process layout:**

- Production is not always continuous. ✓
- Transportation costs between process departments may be high. ✓
- Additional time is spent in testing and sorting as the product moves to the different departments. ✓
- Damage to fragile goods may result from extra handling. ✓

(Any 2 x 1) (2)**2.5 Advantages of the product layout:**

- Handling of material is limited to a minimum. ✓
- Time period of manufacturing cycle is less. ✓
- Production control is almost automatic. ✓
- Control over operations is easier. ✓
- Greater use of unskilled labour is possible. ✓
- Less total inspection is required. ✓
- Less total floor space is needed per unit of production. ✓

(Any 2 x 1) (2)**[10]**

QUESTION 3: MATERIALS (GENERIC)**3.1 Filing test:**

- 3.1.1 Files easily ✓ (1)
- 3.1.2 Hard to file ✓ (1)
- 3.1.3 Files easily ✓ (1)

3.2 Heat treatment:

It is the heating ✓ and cooling ✓ of metals under controlled conditions / as to change their properties. ✓ (3)

3.3 Heating of metal:

If metal is heated too fast, the outside of the metal becomes hotter ✓ than the inside, ✓ then it is very difficult ✓ to achieve a uniform structure. ✓ (4)

3.4 Case hardening:

- Low-carbon steel / Mild steel ✓
- Low-alloy steel ✓ (2)

3.5 Tempering:

- It is to relieve the strains ✓ induced during the hardening process. ✓
- Increase toughness. ✓✓
- Decrease brittleness. ✓✓
- Achieve a finer grain structure. ✓✓

(Any 1 x 2) (2)
[14]

QUESTION 4: MULTIPLE-CHOICE (SPECIFIC)

| | | |
|------|-----|-------------|
| 4.1 | B ✓ | (1) |
| 4.2 | A ✓ | (1) |
| 4.3 | B ✓ | (1) |
| 4.4 | C ✓ | (1) |
| 4.5 | D ✓ | (1) |
| 4.6 | D ✓ | (1) |
| 4.7 | C ✓ | (1) |
| 4.8 | A ✓ | (1) |
| 4.9 | B ✓ | (1) |
| 4.10 | C ✓ | (1) |
| 4.11 | A ✓ | (1) |
| 4.12 | D ✓ | (1) |
| 4.13 | A ✓ | (1) |
| 4.14 | C ✓ | (1) |
| | | [14] |

QUESTION 5: TERMINOLOGY (LATHE AND MILLING MACHINE) (SPECIFIC)**5.1 Disadvantages:**

- The automatic feed of the machine cannot be used. ✓
- Only short length tapers can be cut. ✓
- It causes fatigue in the operator. ✓
- Poor finish. ✓

(Any 3 x 1) (3)**5.2 Taper calculations:****5.2.1 Small diameter:**

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

$$\tan \frac{7}{2} = \frac{85-d}{2 \times 368} \quad \checkmark$$

$$736 \times \tan 3,5 = 85 - d$$

$$45,02 = 85 - d$$

$$d = 85 - 45,02$$

$$d = 39,98 \text{ mm} \quad \checkmark$$

OR

$$\tan 3,5 = \frac{x}{368}$$

$$x = 368 \tan 3,5 \quad \checkmark$$

$$x = 22,51 \text{ mm} \quad \checkmark$$

$$d = D - 2x$$

$$d = 85 - 2(22,5) \quad \checkmark$$

$$d = 39,98 \text{ mm} \quad \checkmark$$

(4)**5.2.2 Set-over of the tailstock:**

$$\text{Set-over} = \frac{L(D-d)}{2l}$$

$$= \frac{488(85-39,98)}{2 \times 368} \quad \checkmark$$

$$= 29,85 \text{ mm} \quad \checkmark$$

(3)**5.3 Key ways:****5.3.1 Width:**

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

$$\text{Width} = \frac{105}{4} \quad \checkmark$$

$$= 26,25 \text{ mm} \quad \checkmark$$

(2)

5.3.2 Thickness:

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

$$\text{Thickness} = \frac{105}{6} \checkmark$$

$$= 17,50 \text{ mm} \checkmark \quad (2)$$

5.3.3 Length:

$$\text{Length} = 1,5 \times \text{diamter of shaft}$$

$$= 1,5 \times 105 \checkmark$$

$$= 157,50 \text{ mm} \checkmark \quad (2)$$

5.4 Safety milling:

- Do not use your hands to remove cuttings while the machine is in motion. ✓
- Use a brush once the machine has stopped. ✓
- Resist the habit of leaning on machinery. ✓
- Do not talk to anyone while you are operating the machine. ✓
- Place saw dust, or oil-absorbing compounds on slippery floors. ✓
- Use a piece of leather or cloth for protection when you handle milling cutters. / Do not use your bare hands when you handle milling cutters. ✓
- Use safety goggles when cutting. ✓
- Do not reach over or near rotating cutters. ✓
- Never leave the machine running unattended. ✓
- Make sure all guards are in place. ✓
- Do not use the machine or come close to its moving parts while wearing loose clothes. ✓
- Never use an air hose to clean the milling machine. ✓
- Stop the machine before you make any adjustments or take measurements. ✓
- Check that there is no oil or grease on the floor around the machine. ✓
- Always clamp workpieces and holding devices safely and firmly. ✓
- Do not use excessive force on the workpiece. ✓

(Any 2 x 1) (2)
[18]

QUESTION 6: TERMINOLOGY (INDEXING) (SPECIFIC)**6.1 Gear terminology:****6.1.1 Circular pitch:**

$$\begin{aligned}
 CP &= m \times \pi \\
 &= 3 \times \pi \checkmark \\
 &= 9,42 \text{ mm } \checkmark
 \end{aligned}$$

(2)

6.1.2 Number of teeth:

$$m = \frac{PCD}{T}$$

$$T = \frac{PCD}{m} \checkmark$$

$$T = \frac{186}{3} \checkmark$$

$$T = 62 \text{ teeth } \checkmark$$

OR

$$PCD = \frac{CP \times T}{\pi}$$

$$186 = \frac{9,42 \times T}{\pi} \checkmark$$

$$T = \frac{186 \times \pi}{9,42} \checkmark$$

$$= 62 \text{ teeth } \checkmark$$

(3)

6.1.3 Dedendum:

$$\begin{aligned}
 \text{Dedendum} &= 1,157 \times m \\
 &= 1,157 \times 3 \checkmark \\
 &= 3,47 \text{ mm } \checkmark
 \end{aligned}$$

OR

$$\begin{aligned}
 \text{Dedendum} &= 1,25 \times m \\
 &= 1,25 \times 3 \checkmark \\
 &= 3,75 \text{ mm } \checkmark
 \end{aligned}$$

(2)

6.2 **Dovetails:**6.2.1 **Maximum width distance of dovetail: (W)****Calculate DE or y:**

$$\tan \alpha = \frac{DE}{AD}$$

$$\begin{aligned} DE &= \tan \alpha \times AD \checkmark \\ &= \tan 30^\circ \times 32 \checkmark \\ &= 18,48 \text{ mm} \checkmark \end{aligned}$$

OR

$$\tan \theta = \frac{AD}{DE}$$

$$\tan 60^\circ = \frac{32}{DE} \checkmark$$

$$\begin{aligned} DE &= \frac{32}{\tan 60^\circ} \checkmark \\ &= 18,48 \text{ mm} \checkmark \end{aligned}$$

$$\begin{aligned} W &= 125 + 2(DE) \checkmark \\ &= 125 + 2(18,48) \checkmark \\ &= 125 + 36,96 \\ &= 161,96 \text{ mm} \checkmark \end{aligned}$$

(6)

6.2.2 Distance over the rollers: (M)**Calculate AC or x:**

$$\tan \alpha = \frac{BC}{AC}$$

$$AC = \frac{BC}{\tan \alpha} \quad \checkmark$$

$$= \frac{7}{\tan 30^\circ} \quad \checkmark$$

$$= 12,12 \text{ mm} \quad \checkmark$$

$$\tan \theta = \frac{AC}{BC}$$

$$AC = \tan \theta \times BC \quad \checkmark$$

$$= \tan 60^\circ \times 7 \quad \checkmark$$

$$= 12,12 \text{ mm} \quad \checkmark$$

OR

$$\begin{aligned} M &= w + [2(AC) + 2(R)] \quad \checkmark \\ &= 125 + [2(12,12) + 2(7)] \quad \checkmark \\ &= 125 + (24,24 + 14) \\ &= 163,24 \text{ mm} \quad \checkmark \end{aligned}$$

OR

$$\begin{aligned} M &= w + 2(AC + R) \quad \checkmark \\ &= 125 + 2(12,12 + 7) \quad \checkmark \\ &= 125 + 24,24 + 14 \\ &= 163,24 \text{ mm} \quad \checkmark \end{aligned}$$

OR

$$\begin{aligned} M &= w + 2(AC) + 2(R) \quad \checkmark \\ &= 125 + 2(12,12) + 2(7) \quad \checkmark \\ &= 125 + 24,24 + 14 \\ &= 163,24 \text{ mm} \quad \checkmark \end{aligned}$$

(6)

6.3 Milling of spur gear:**6.3.1 Indexing:**

$$\begin{aligned}
 \text{Indexing} &= \frac{40}{n} \\
 &= \frac{40}{101} \\
 \text{Indexing} &= \frac{40}{A} \\
 &= \frac{40}{100} \checkmark \\
 &= \frac{2}{5} \times \frac{5}{5} \checkmark \\
 &= \frac{10}{25} \checkmark
 \end{aligned}$$

Approximate indexing:

No full turns and 10 holes on a 25-hole circle ✓

OR

No full turns and 12 holes on a 30-hole circle ✓

(4)

6.3.2 Change gears:

$$\begin{aligned}
 \frac{Dr}{Dn} &= (A - n) \times \frac{40}{A} \\
 \frac{Dr}{Dn} &= (100 - 101) \times \frac{40}{100} \checkmark \\
 &= -1 \times \frac{40}{100} \\
 &= \frac{-40}{100} \checkmark \\
 \frac{Dr}{Dn} &= \frac{40}{100} \checkmark
 \end{aligned}$$

OR

$$\begin{aligned}
 \frac{Dr}{Dn} &= \frac{(A - n)}{A} \times \frac{40}{1} \\
 \frac{Dr}{Dn} &= \frac{(100 - 101)}{100} \times \frac{40}{1} \checkmark \\
 &= -\frac{2}{5} \times \frac{20}{20} \checkmark \\
 \frac{Dr}{Dn} &= \frac{40}{100} \checkmark
 \end{aligned}$$

(5)
[28]

QUESTION 7: TOOLS AND EQUIPMENT (SPECIFIC)**7.1 Different indenters:**

7.1.1 On the anvil/platform. ✓ (1)

7.1.2 • By calculation ✓
• Using the table ✓ (2)

7.2 Label A-D:

A. Datum line/Reading line ✓
B. Fixed anvil ✓
C. Thimble ✓
D. Ratchet ✓ (4)

7.3 Function of screw thread micrometer:

To measure ✓ the pitch diameter ✓ of a screw thread. (2)

7.4 Height of a screw thread:

$H = 0,866 \times \text{Pitch (P)}$
 $H = 0,866 \times 2,5$ ✓
 $H = 2,17 \text{ mm}$ ✓ (2)

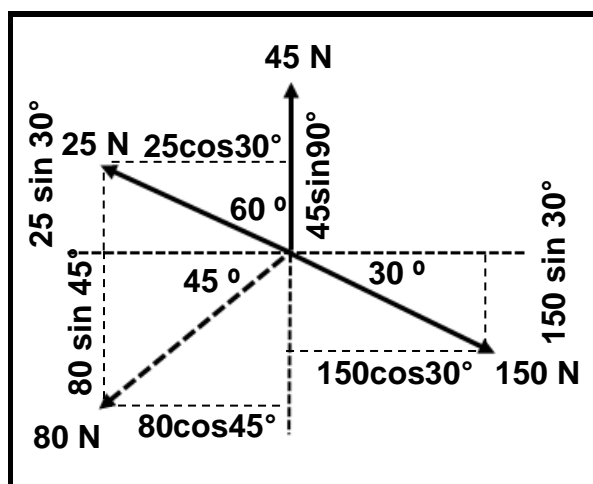
7.5 Reading of depth micrometer:

The depth micrometer reads in the opposite direction. / In a depth micrometer the reading is taken from right to left and a screw thread micrometer reads from left to right on the datum line. ✓ (1)

7.6 Interchangeable rods:

• Interchangeable rods are used to measure extra depth. ✓
• Interchangeable rods are used to measure more than 25 mm. ✓
(Any 1 x 1) (1)

[13]

QUESTION 8: FORCES (SPECIFIC)**8.1 System of forces:****8.1.1 Σ Horizontal component:**

$$\Sigma HC = 45\cos 90^\circ - 25\cos 30^\circ - 80\cos 45^\circ + 150\cos 30^\circ$$

$$\Sigma HC = 0 - 21,65 - 56,57 + 129,90$$

$$\Sigma HC = 51,68\text{ N} \checkmark$$

(4)

8.1.2 Σ Vertical component:

$$\Sigma VC = 45\sin 90^\circ + 25\sin 30^\circ - 80\sin 45^\circ - 150\sin 30^\circ$$

$$\Sigma VC = 45 + 12,5 - 56,57 - 75$$

$$\Sigma VC = -74,07\text{ N} \checkmark$$

(5)

OR

| Force | θ | 8.1.2 $\Sigma VC/y = F\sin\theta$ | | 8.1.1 $\Sigma HC/x = F\cos\theta$ | |
|-------|----------|-----------------------------------|------------------|-----------------------------------|-----------------|
| 45N | 90° | VC = 45sin90° | 45 N ✓ | HC = 45cos90° | 0 N |
| 25N | 150° | VC = 25sin150° | 12,5 N ✓ | HC = 25cos150° | -21,65 N ✓ |
| 80N | 225° | VC = 80sin225° | - 56,57 N ✓ | HC = 80cos225° | -56,57 N ✓ |
| 150N | 330° | VC = 150sin330° | -75 N ✓ | HC = 150cos330° | 129,90 N ✓ |
| | | Total | -74,07N ✓ | | 51,68N ✓ |

8.1.3 Resultant:

$$R^2 = VC^2 + HC^2$$

$$\sqrt{R^2} = \sqrt{(-74,04)^2 + (51,68)^2} \checkmark$$

$$R = 90,32 \text{ N} \checkmark$$

(2)

8.1.4 Angle and direction of equilibrant:

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

$$\theta = \tan^{-1} \left(\frac{-74,07}{51,68} \right) \checkmark$$

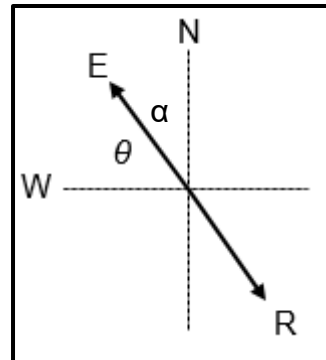
$$\theta = 55,10^\circ \checkmark$$

OR

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

$$\alpha = \tan^{-1} \left(\frac{51,68}{-74,07} \right) \checkmark$$

$$\alpha = 34,90^\circ \checkmark$$

**Direction:**

$$E = 90,32 \text{ N } 55,10^\circ \text{ N from W} \checkmark$$

OR

$$E = 90,32 \text{ N } 34,90^\circ \text{ W from N} \checkmark$$

OR

$$E = \text{At a Bearing of } 325,10^\circ$$

(3)

8.2 Calculations, UDL and supports A and B.**8.2.1 UDL:**

$$\text{UDL} = 10 \text{ N/m} \times 4 \text{ m} \checkmark$$

$$\text{UDL} = 40 \text{ N} \checkmark$$

(2)

8.2.2 Reaction in support A:

Take moments about B:

$$\Sigma \text{LHM} = \Sigma \text{RHM}$$

$$(60 \times 1,5) + (40 \times 5) + (75 \times 11) = (A \times 12)$$

$$90 + 200 + 825 = 12A$$

$$A = \frac{1115}{12}$$

$$A = 92,92 \text{ N} \checkmark$$

Reaction in support B:

Take moments about A:

$$\Sigma \text{LHM} = \Sigma \text{RHM}$$

$$(B \times 12) = (75 \times 1) + (40 \times 7) + (60 \times 10,5)$$

$$12B = 75 + 280 + 630$$

$$B = \frac{985}{12}$$

$$B = 82,08 \text{ N} \checkmark$$

(8)

8.3 Stress calculations:**8.3.1 Stress:**

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

$$\sigma = \frac{110000}{7,07 \times 10^{-4}} \checkmark$$

$$\sigma = 155586987,3$$

$$\sigma = 155,59 \text{ MPa} \checkmark$$

(2)

8.3.2 Diameter:

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

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

$$d = \sqrt{\frac{4(7,07 \times 10^{-4})}{\pi}} \quad \checkmark$$

$$d = 0,03 \text{ m} \quad \checkmark$$

$$d = 30 \text{ mm} \quad \checkmark$$

(4)

8.3.3 The original length:

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

$$oL = \frac{\Delta L}{\varepsilon} \quad \checkmark$$

$$oL = \frac{0,0001}{1,64 \times 10^{-5}} \quad \checkmark$$

$$oL = 6,1 \text{ m}$$

$$oL = 6097,56 \text{ mm} \quad \checkmark$$

(3)

[33]

QUESTION 9: MAINTENANCE (SPECIFIC)**9.1 Mechanical drives:**

- Gear drive ✓
- Belt drive ✓
- Chain drive ✓
- Hydraulic drives ✓
- Pneumatic drives ✓
- Shaft drives ✓

(Any 3 x 1) (3)**9.2 Maintenance on operating systems:**

- Maintenance is to ensure that the system/machine always operates ✓ at an optimal level. ✓
- Prevent machinery from breakdown ✓ and let the machines last longer. ✓

(Any 1 x 2) (2)**9.3 Preventative maintenance procedures on gear drives:**

- Check and refill lubricant levels. ✓
- Ensure that gears are properly secured to shafts. ✓
- Cleaning and replacement of oil filters. ✓
- Reporting excessive noise and wear, vibration and overheating for expert attention. ✓
- Make sure that the gears are properly aligned. ✓
- Ensure that the correct type of oil/lubricant is used. ✓

(Any 3 x 1) (3)**9.4 Subgroups of preventative maintenance:**

- Planned/Scheduled maintenance ✓
- Condition-based maintenance ✓

(2)**9.5 Polyester resins:**

To strengthen the glass fibre. ✓

(1)**9.6 Lack of preventive maintenance:**

- Risk of injury. ✓
- Risk of death. ✓
- Financial loss. ✓
- Damage of machines/equipment. ✓
- Poor performance of machines/equipment. ✓
- Loss of valuable production time. ✓
- Damage to material/work piece. ✓

(Any 3 x 1) (3)

9.7 **Thermo-hardened and thermoplastic composites:**

Thermo-hardened: This material cannot be re-heated ✓ to be softened, shaped and moulded. ✓

Thermoplastic: These plastics can be re-heated ✓ and therefore reshaped in various ways. ✓

(4)
[18]

QUESTION 10: JOINING METHODS (SPECIFIC)**10.1 Square thread:****10.1.1 Pitch diameter:**

$$\begin{aligned}\text{Pitch} &= \frac{\text{Lead}}{\text{Number of starts}} \\ &= \frac{40}{4} \checkmark \\ &= 10 \text{ mm} \checkmark\end{aligned}$$

$$\begin{aligned}\text{PD} &= \text{OD} - \frac{P}{2} \\ &= 105 - \frac{10}{2} \checkmark \\ &= 100 \text{ mm} \checkmark\end{aligned}$$

(4)

10.1.2 Helix angle of the thread:

$$\begin{aligned}\tan \theta &= \frac{\text{Lead}}{\pi \times \text{PD}} \\ \tan \theta &= \frac{40}{\pi \times 100} \checkmark\end{aligned}$$

$$\begin{aligned}\theta &= \tan^{-1}(0,127323954) \checkmark \\ &= 7,26^\circ \checkmark\end{aligned}$$

(4)

10.1.3 Leading angle:

$$\begin{aligned}\text{Leading angle} &= 90^\circ - (\text{helix angle} + \text{clearance angle}) \\ &= 90^\circ - (7,26^\circ + 4^\circ) \checkmark \\ &= 78,74^\circ \checkmark\end{aligned}$$

(2)

10.1.4 Following angle:

$$\begin{aligned}\text{Following angle} &= 90^\circ + (\text{helix angle} - \text{clearance angle}) \\ &= 90^\circ + (7,26^\circ - 4^\circ) \checkmark \\ &= 93,26^\circ \checkmark\end{aligned}$$

(2)

10.2 **Square thread:**

- A. Crest- /Outside- /Major- /Nominal diameter ✓
- B. Pitch- /Effective- /Mean diameter ✓
- C. Helix angle ✓
- D. Cutting tool ✓

(4)

10.3 **Uses of square thread:**

- Power transmissions ✓
- Vice screws ✓
- Lathe lead and feed screws / half nuts ✓
- Press screws ✓
- Clamping devices ✓
- Linear actuators ✓
- Adjustment mechanisms ✓
- Tapping and thread cutting ✓
- Threaded spindles ✓
- Lifting mechanisms ✓

(Any 2 x 1)

(2)

[18]

QUESTION 11: SYSTEMS AND CONTROL (DRIVE SYSTEMS) (SPECIFIC)**11.1 Hydraulic systems:****11.1.1 Fluid pressure:**

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

$$P = \frac{600}{0,2} \quad \checkmark$$

$$P = 3000 \text{ Pa} \quad \checkmark$$

(2)

11.1.2 Force applied:

$$P = \frac{f}{a}$$

$$f = P \times a \quad \checkmark$$

$$f = 3000 \times 0,018 \quad \checkmark$$

$$f = 54 \text{ N} \quad \checkmark$$

(3)

11.1.3 Displacement ℓ :

$$V_{\text{Plunger}} = V_{\text{Ram}}$$

$$a \times \ell = A \times L$$

$$\ell = \frac{A \times L}{a} \quad \checkmark$$

$$\ell = \frac{0,2 \times 0,03}{0,018} \quad \checkmark$$

$$\ell = 0,333 \text{ m}$$

$$\ell = 333,3 \text{ mm} \quad \checkmark$$

(3)

11.2 Hydraulic pressure:Pressure gauge \checkmark

(1)

11.3 Purpose of hydraulic filter:

- To restrict dirt in system. \checkmark
- To protect the pump. \checkmark
- Protect the valves. \checkmark
- Protect the actuators. \checkmark

(Any 1 x 1) (1)

11.4 Hydraulic valve:**11.4.1 Identify valve:**

- Non-return valve ✓
- One-way valve ✓

(Any 1 x 1) (1)**11.4.2 Functions:**

- Ensure one direction flow. ✓
- Prevent back flow. ✓
- Act as a pressure relief valve. ✓

(Any 2 x 1) (2)**11.5 Belt drive:****11.5.1 Rotational frequency:**

$$N_{DN} \times D_{DN} = N_{DR} \times D_{DR}$$

$$N_{DR} = \frac{N_{DN} \times D_{DN}}{D_{DR}} \quad \checkmark$$

$$N_{DR} = \frac{1100 \times 600}{220} \quad \checkmark$$

$$N_{DR} = \frac{3000 \text{ r/min}}{60}$$

$$N_{DR} = 50 \text{ r/sec} \quad \checkmark$$

(4)**11.5.2 Torque:**

$$P = \frac{2 \times \pi \times N \times T}{60}$$

$$T = \frac{P \times 60}{2 \times \pi \times N} \quad \checkmark$$

$$T = \frac{236,65 \times 10^3 \times 60}{2 \times \pi \times 1100} \quad \checkmark$$

$$T = 2054,40 \text{ Nm} \quad \checkmark$$

(3)

11.6 Gear drive:**11.6.1 Rotational frequency of the output shaft N_A in r/s:**

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

$$\frac{N_A}{N_D} = \frac{T_B \times T_D}{T_A \times T_C} \checkmark$$

$$\frac{980}{N_D} = \frac{24 \times 42}{45 \times 20} \checkmark$$

$$N_D = \frac{45 \times 20 \times 980}{24 \times 42}$$

$$N_D = 875 \text{ r/min}$$

$$N_D = 14,58 \text{ r/sec} \checkmark$$

(4)

11.6.2 Gear ratio:

$$\text{Gear ratio} = \frac{\text{Product of teeth on driven gear}}{\text{Product of teeth on driver gear}}$$

$$\text{Gear ratio} = \frac{24 \times 42}{45 \times 20} \checkmark$$

$$\text{Gear ratio} = 1,12 : 1 \checkmark$$

OR

$$\text{Gear ratio} = \frac{N_{\text{input}}}{N_{\text{output}}}$$

$$\text{Gear ratio} = \frac{16,33}{14,58} \checkmark \text{ OR } \frac{980}{875} \checkmark$$

$$\text{Gear ratio} = 1,12 : 1 \checkmark$$

(3)

11.6.3 Direction:Clockwise \checkmark (1)
[28]**TOTAL: 200**