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Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

MECHANICAL TECHNOLOGY: FITTING AND MACHINING

NOVEMBER 2023

MARKING GUIDELINES

MARKS: 200

These marking guidelines consist of 27 pages.

QUESTION 1: MULTIPLE-CHOICE (GENERIC)

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

QUESTION 2: SAFETY (GENERIC)**2.1 Examination checks:**

- Severe bleeding ✓
- Internal bleeding ✓
- Head injuries ✓
- Neck injuries ✓
- Fractures ✓
- Vital signs ✓
- Physical abnormalities ✓

(Any 2 x 1) (2)**2.2 Safety devices on the power-driven guillotine:**

- Finger protectors / Fixed guards / Blade guard ✓
- Rear view mirrors ✓
- Rear light curtains ✓
- Automatic sweep-away ✓
- Revolving warning lights ✓
- Two-hand / dual control device ✓
- Additional emergency buttons ✓
- Self-adjusting guards ✓
- Covered footswitch ✓

(Any 2 x 1) (2)**2.3 Grinding wheel:**

- The wheel should be rated above the speed of the motor. ✓
- Check for cracks on the grinding wheel. ✓
- Check for chips on the grinding wheel. ✓
- Check that the arbor hole is the correct size. ✓
- Must not be contaminated by oil/fluids or grease. ✓
- Correct size of the wheel. ✓
- Correct type of wheel for the material. ✓

(Any 2 x 1) (2)**2.4 Gas welding equipment – safety devices:**

- Valve guard ✓
- Flash back arrestor ✓
- Pressure regulator ✓
- C-clamps on hoses/Parallel hose clips ✓
- Acetylene spindle key must always be in place. ✓
- Cylinder valves. ✓

(Any 2 x 1) (2)

2.5 **Advantages of process layout of machines are:**

- High machine utilisation. ✓
- Better supervision. ✓
- Less interruption in the flow of work. ✓
- Lower equipment costs. ✓
- Better control of total manufacturing costs. ✓
- Greater flexibility. ✓

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

QUESTION 3: MATERIALS (GENERIC)**3.1 Colour code of metal:**

- To identify the type of metal. ✓
- To identify carbon content especially after the metal was stored. ✓
- To identify the profile/size of the metal. ✓

(Any 1 x 1) (1)**3.2 Tests to determine properties of steel:****3.2.1 Sound test:**

- Hardness ✓
- Softness ✓

(Any 1 x 1) (1)**3.2.2 Bending test:**

- Ductility ✓
- Bend strength ✓
- Fracture strength ✓
- Resistance to fracture
- Brittleness ✓
- Elasticity ✓
- Plasticity ✓
- Flexibility ✓

(Any 1 x 1) (1)**3.2.3 Machining test:**

- Hardness ✓
- Strength ✓

(Any 1 x 1) (1)**3.3 Reasons metal soaked during heat treatment:**

- To ensure uniform heat distribution ✓ throughout the metal. ✓
- To achieve a uniform grain structure ✓ after cooling the metal. ✓

(Any 1 x 2) (2)**3.4 Case hardening:**

- Carburising ✓
- Nitriding ✓
- Cyaniding ✓

(Any 2 x 1) (2)**3.5 Annealing process:**

Heating the steel slightly above AC_3 , (upper critical temperature) ✓ soaking it for a required time/period ✓ and then slow cooling ✓ back to room temperature.

(3)

3.6 **Rapid quenching mediums:**

- Brine/Salt water ✓
- Water ✓
- Nitrogen ✓
- Oil ✓

(Any 2 x 1) (2)

3.7 **Heat treatment process:**

Tempering ✓

(1)

[14]

QUESTION 4: MULTIPLE-CHOICE (SPECIFIC)

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

QUESTION 5: TERMINOLOGY (LATHE AND MILLING MACHINE) (SPECIFIC)**5.1 Disadvantages of compound slide method**

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

(Any 2 x 1) (2)**5.2 Taper calculations:****5.2.1 Length of taper:**

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

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

$$2l = \frac{78-55}{\tan 4^\circ} \quad \checkmark$$

$$2l = \frac{23}{0,069926811}$$

$$l = \frac{328,9153283}{2} \quad \checkmark$$

$$l = 164,46 \text{ mm} \quad \checkmark$$

(4)**5.2.2 Tailstock set-over:**

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

$$= \frac{\overset{\checkmark}{284,46}(\overset{\checkmark}{78-55})}{2 \times 164,46 \quad \checkmark}$$

$$= 19,89 \text{ mm} \quad \checkmark$$

(4)

5.3 Key ways:**5.3.1 Width:**

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

$$\text{Width} = \frac{83}{4} \checkmark$$

$$= 20,75 \text{ mm} \checkmark$$

(2)

5.3.2 Thickness:

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

$$\text{Thickness} = \frac{83}{6} \checkmark$$

$$= 13,83 \text{ mm} \checkmark$$

(2)

5.3.3 Length:

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

$$= 1,5 \times 83 \checkmark$$

$$= 124,50 \text{ mm} \checkmark$$

(2)

5.4 Straddle milling:A. Side and face cutter / Milling cutters. \checkmark B. Arbor / Spacers / Spindle / Axle \checkmark

(2)

[18]

QUESTION 6: TERMINOLOGY (INDEXING) (SPECIFIC)**6.1 Gear terminology:****6.1.1 Pitch-circle diameter:**

$$\begin{aligned} \text{PCD} &= m \times T \\ &= 2,5 \times 180 \checkmark \\ &= 450 \text{ mm } \checkmark \end{aligned}$$

$$\begin{aligned} \text{CP} &= m \times \pi \\ &= 2,5 \times \pi \\ &= 7,85 \text{ mm } \checkmark \end{aligned}$$

$$\begin{aligned} \text{OR } \text{PCD} &= \frac{\text{CP} \times T}{\pi} \\ &= \frac{7,85 \times 180}{\pi} \\ &= 450 \text{ mm } \checkmark \end{aligned} \quad (2)$$

6.1.2 Dedendum:

$$\begin{aligned} \text{Dedendum} &= 1,157 \times m \\ &= 1,157 \times 2,5 \checkmark \\ &= 2,89 \text{ mm } \checkmark \end{aligned}$$

$$\begin{aligned} \text{OR } \text{Dedendum} &= 1,25 \times m \\ &= 1,25 \times 2,5 \checkmark \\ &= 3,13 \text{ mm } \checkmark \end{aligned} \quad (2)$$

6.1.3 Outside diameter:

$$\begin{aligned} \text{OD} &= \text{PCD} + 2(m) \\ &= 450 + 2(2,5) \checkmark \\ &= 455 \text{ mm } \checkmark \end{aligned}$$

(2)

6.2 Dovetails:

$$W = 136 + 2(DE)$$

$$m = W - [2(AC) + 2(R)] \quad \text{OR} \quad m = W - 2(AC + R) \quad \text{OR} \quad m = W - 2(AC) - 2(R)$$

6.2.1 Maximum width distance of dove tail: (W)**Calculate DE or y:**

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

$$\begin{aligned} DE &= \tan \theta \times AD \quad \checkmark \\ &= \tan 30^\circ \times 50 \quad \checkmark \\ &= 28,87 \text{ mm} \quad \checkmark \end{aligned}$$

OR

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

$$\begin{aligned} \tan 60^\circ &= \frac{50}{DE} \quad \checkmark \\ DE &= \frac{50}{\tan 60^\circ} \quad \checkmark \\ &= 28,87 \text{ mm} \quad \checkmark \end{aligned}$$

$$\begin{aligned} W &= 136 + 2(DE) \quad \checkmark \\ &= 136 + 2(28,87) \quad \checkmark \\ &= 136 + 57,74 \\ &= 193,74 \text{ mm} \quad \checkmark \end{aligned}$$

(6)

6.2.2 Distance between the rollers: (m)**Calculate AC or x:**

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

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

$$= \frac{10}{\tan 30^\circ} \quad \checkmark$$

$$= 17,32 \text{ mm} \quad \checkmark$$

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

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

$$= \tan 60^\circ \times 10 \quad \checkmark$$

$$= 17,32 \text{ mm} \quad \checkmark$$

OR

$$\begin{aligned} m &= W - [(2(AC) + 2(R))] \quad \checkmark \\ &= 193,74 - [2(17,32) + 2(10)] \quad \checkmark \\ &= 193,74 - (34,64 + 20) \\ &= 139,10 \text{ mm} \quad \checkmark \end{aligned}$$

OR

$$\begin{aligned} m &= W - 2(AC + R) \quad \checkmark \\ &= 193,74 - 2(17,32 + 10) \quad \checkmark \\ &= 193,74 - (34,64 + 20) \\ &= 139,10 \text{ mm} \quad \checkmark \end{aligned}$$

OR

$$\begin{aligned} m &= W - 2(AC) - 2(R) \quad \checkmark \\ &= 193,74 - 2(17,32) - 2(10) \quad \checkmark \\ &= 193,74 - 34,64 - 20 \\ &= 139,10 \text{ mm} \quad \checkmark \end{aligned}$$

(6)

6.3 Milling of spur gear:

6.3.1 Indexing:

$$\begin{aligned}\text{Indexing} &= \frac{40}{N} = \frac{40}{89} \\ &= \frac{40}{A} = \frac{40}{90} \checkmark \\ &= \frac{4}{9} \times \frac{6}{6} \\ &= \frac{24}{54} \checkmark\end{aligned}$$

= Indexing : 0 full turns and 24 holes on a 54 – hole circle \checkmark (3)

6.3.2 Change gears:

$$\frac{D_r}{D_n} = (A - n) \times \frac{40}{A}$$

$$\frac{D_r}{D_n} = (90 - 89) \times \frac{40}{90} \checkmark$$

$$= 1 \times \frac{40}{90}$$

$$= \frac{40}{90} \checkmark$$

$$= \frac{4}{9}$$

$$= \frac{4}{9} \times \frac{8}{8} \checkmark$$

$$\frac{D_r}{D_n} = \frac{32}{72} \checkmark$$

$$\frac{\text{Driver}}{\text{Driven}} = \frac{A - N}{A} \times \frac{40}{1}$$

$$= \frac{90 - 89}{90} \times \frac{40}{1} \checkmark$$

$$= \frac{1}{90} \times \frac{40}{1}$$

$$= \frac{40}{90} \checkmark$$

$$= \frac{4}{9} \times \frac{8}{8} \checkmark$$

$$\frac{D_r}{D_n} = \frac{32}{72} \checkmark$$

OR

(5)

6.4 **Balancing constraints/disadvantages:**

- Requires specialised machinery. ✓
- Difficult to ascertain the exact point of unbalance. ✓
- Requires accurate removal or adding of material (weight) to the object. ✓
- Can lead to interference with parts of the machine when weights are added to parts. ✓

(Any 2 x 1)

(2)

[28]

QUESTION 7: TOOLS AND EQUIPMENT (SPECIFIC)

- 7.1 **Instrument to measure indentation:**
Microscope ✓ (1)
- 7.2 **Brinell hardness number:**
 - Calculations ✓
 - The use of a Brinell hardness table ✓
(2)
- 7.3 **Function of moment tester:**
To determine the reactions on either side of a simply loaded beam. ✓ (1)
- 7.4 **Principal of tensile tester:**
The tensile tester is a destructive ✓ tester that subjects a piece of material to an increasing axial load ✓ while measuring the corresponding elongation of the material. ✓ (3)
- 7.5 **Depth and screw-thread micrometer:**
The scale on the depth micrometer's barrel reads in the opposite direction compared to the screw thread micrometer. ✓ (1)
- 7.6 **Hardness assessment:**
 - Resistance to penetration / Hardness tests ✓
 - Sound test ✓
 - Elastic hardness / Bending test / Tensile test ✓
 - Resistance to abrasion / File test / Spark test / Machining test ✓**(Any 3 x 1)** (3)
- 7.7 **Micrometer measurement:**

$$5,94 + 50 = 55,94 \text{ mm}$$

✓
✓

(2)
[13]

QUESTION 8: FORCES (SPECIFIC)**8.1 Forces:****8.1.1 Horizontal component:**

$$\Sigma HC = 45\cos 0^\circ + 75\cos 30^\circ - 15\cos 75^\circ - 120\cos 270^\circ$$

$$\Sigma HC = 45 + 64,95 - 3,88 - 0$$

$$\Sigma HC = 106,07 \text{ N} \quad \checkmark \quad (4)$$

8.1.2 Vertical component:

$$\Sigma VC = 45\sin 0^\circ + 75\sin 30^\circ + 15\sin 75^\circ - 120\sin 270^\circ$$

$$\Sigma VC = 0 + 37,5 + 14,49 - 120$$

$$\Sigma VC = -68,01 \text{ N} \quad \checkmark \quad (4)$$

OR

Force	θ	8.1.1 $\Sigma HC/x = F\cos\theta$	8.1.2 $\Sigma VC/y = F\sin\theta$
45N	0°	HC = $45\cos 0^\circ$ 45N \checkmark	VC = $45\sin 0^\circ$ 0N
75N	30°	HC = $75\cos 30^\circ$ 64,95N \checkmark	VC = $75\sin 30^\circ$ 37,5N \checkmark
15N	105°	HC = $15\cos 105^\circ$ -3,88N \checkmark	VC = $15\sin 105^\circ$ 14,49N \checkmark
120N	270°	HC = $120\cos 270^\circ$ 0N	VC = $120\sin 270^\circ$ -120N \checkmark
		Total 106,07N \checkmark	-68,01N \checkmark

(8)

8.1.3 Resultant:

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

$$R = \sqrt{(-68,01)^2 + (106,07)^2} \quad \checkmark$$

$$R = \sqrt{15876,21}$$

$$R = 126,00 \text{ N} \quad \checkmark$$

(2)

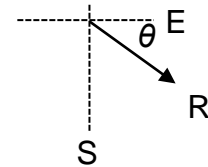
8.1.4 **Angle and direction of resultant:**
Angle:

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

$$\theta = \tan^{-1} \left(\frac{-68,01}{106,07} \right) \checkmark$$

$$\theta = \tan^{-1}(0,64)$$

$$\theta = 32,67^\circ \checkmark$$

**Direction:**

R = 126,00N 32,67° / 32° 40' South of East ✓

OR

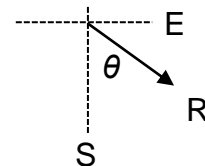
Angle:

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

$$\theta = \tan^{-1} \left(\frac{106,07}{-68,01} \right) \checkmark$$

$$\theta = \tan^{-1}(1,559623585)$$

$$\theta = 57,20^\circ \checkmark$$

**Direction:**

R = 126,00N 57,33° / 57° 20' East of South ✓

(4)

8.2 Reaction in supports A and B:**Reaction in support A:****Take moments about B:**

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

$$(\overset{\checkmark}{55} \times \overset{\checkmark}{7}) = (\overset{\checkmark}{A} \times \overset{\checkmark}{7}) + (\overset{\checkmark}{160} \times \overset{\checkmark}{1,5})$$

$$385 = 7A + 240$$

$$A = \frac{145}{7} \checkmark$$

$$A = 20,71 \text{ N } \checkmark$$

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

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

$$(\overset{\checkmark}{B} \times \overset{\checkmark}{7}) = (\overset{\checkmark}{55} \times \overset{\checkmark}{0}) + (\overset{\checkmark}{160} \times \overset{\checkmark}{8,5})$$

$$7B = 0 + 1360$$

$$B = \frac{1360}{7} \checkmark$$

$$B = 194,29 \text{ N } \checkmark$$

(9)

8.3 Stress and strain:**8.3.1 Maximum load:**

$$\begin{aligned}
 A &= \frac{\pi D^2}{4} \\
 &= \frac{\pi 0,02^2}{4} \checkmark \\
 &= 3,14159265 \times 10^{-4} \text{m}^2 \checkmark \text{ OR } 3,14 \times 10^{-4} \text{m}^2 \checkmark
 \end{aligned}$$

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

$$F = A \times \sigma \checkmark$$

$$\begin{aligned}
 F &= 3,14159265 \times 10^{-4} \times 640 \times 10^6 \checkmark \\
 F &= 201061,93 \text{ N} \\
 F &= 201,06 \text{ kN} \checkmark \text{ OR } 200,96 \text{ kN} \checkmark
 \end{aligned}$$

(6)

8.3.2 Safe working stress:

$$SF = \frac{MS}{SS}$$

$$SS = \frac{MS}{SF} \checkmark$$

$$SS = \frac{640 \times 10^6}{3} \checkmark$$

$$SS = 213333333,3 \text{ Pa}$$

$$SS = 213,33 \text{ MPa} \checkmark$$

(4)

[33]

QUESTION 9: MAINTENANCE (SPECIFIC)**9.1 Preventative maintenance:****Subgroups of preventative maintenance:**

- Planned or scheduled maintenance ✓
- Conditional-based maintenance ✓

(2)

9.2 Advantages of belt drives over gear drives:

- Produce less noise than gear drives. ✓
- Produce less vibration than gear drives. ✓
- More cost effective. ✓
- Belt drives will slip under a sudden load /over load to protect the drive. ✓
- Do not need lubrication like gear drives. ✓
- Belt drives do not require parallel shafts. ✓
- Belts can be used over long distances. ✓

(Any 3 x 1) (3)

9.3 Belt drives:

- V-pulley ✓
- Wedge pulley ✓
- Flat pulley ✓
- Round belt ✓
- Timing/Toothed belt ✓
- Multi-groove belt ✓

(Any 3 x 1) (3)

9.4 Non-stick material:

Teflon ✓

(1)

9.5 Uses:**Polyvinyl chloride (PVC):**

- 9.5.1
- Trays for food and toiletries ✓
 - Clear bottles ✓
 - Blister packaging ✓
 - Drain and sewerage pipes ✓
 - Electrical pipes ✓
 - Drip bags ✓
 - Cooking bottles ✓
 - Vinegar bottles ✓
 - Credit cards ✓
 - Shoe soles ✓
 - Floor tiles ✓
 - Wallpaper ✓
 - Outdoor furniture ✓
 - Disposable cutlery ✓

(Any 2 x 1) (2)

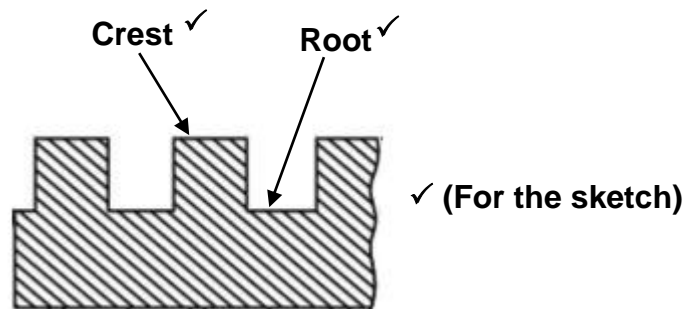
9.5.2 Bakelite:

- Electrical insulators ✓
- Kitchenware ✓
- Jewellery ✓
- Toys ✓
- Distributor rotors ✓
- Disc brake cylinders ✓
- Sauce pan handles ✓
- Electrical switches ✓
- Electrical parts ✓
- Aircraft components ✓
- Bearings ✓
- Clutch linings ✓
- Brake linings ✓
- Laminated materials ✓
- Computer motherboards ✓

(Any 2 x 1) (2)**9.5.3 Fibre Glass**

- Surface covering ✓
- Woven cloth ✓
- Pillow stuffing ✓
- Reinforced plastics ✓
- Boats ✓
- Motor vehicle bodies ✓
- Roof sheeting ✓
- Petrol tanks ✓
- Swimming pools ✓
- Furniture ✓
- Fruit and salad bowls ✓
- Ornaments ✓
- Sporting equipment ✓
- Jigs forms ✓

(Any 2 x 1) (2)**9.6 Thermo-hardened or thermoplastic:****9.6.1 Carbon fibre:**Thermo-hardened / Thermosetting ✓ **(1)****9.6.2 Nylon:**Thermoplastic ✓ **(1)****9.6.3 Bakelite:**Thermo-hardened / Thermosetting ✓ **(1)****[18]**

QUESTION 10: JOINING METHODS (SPECIFIC)**10.1 Square screw thread:**

(3)

10.2 Square Thread:**10.2.1 Pitch diameter:**

$$\begin{aligned}\text{Pitch} &= \frac{\text{Lead}}{\text{Number of starts}} \\ &= \frac{25}{2} \checkmark \\ &= 12,50 \text{ mm} \checkmark\end{aligned}$$

$$\begin{aligned}\text{PD} &= \text{OD} - \frac{P}{2} \\ &= 70 - \frac{12,50}{2} \checkmark \\ \text{PD} &= 63,75 \text{ mm} \checkmark\end{aligned}$$

(4)

10.2.2 Helix angle of the thread:

$$\begin{aligned}\tan \theta &= \frac{\text{Lead}}{\pi \times D_p} \\ \tan \theta &= \frac{25}{\pi \times 63,75} \checkmark \\ \theta &= \tan^{-1}(0,124827406) \checkmark \\ &= 7,12^\circ \text{ OR } 7^\circ 7' \checkmark\end{aligned}$$

(4)

10.2.3 Leading angle:

$$\begin{aligned}\text{Leading angle} &= 90^\circ - (\text{Helix angle} + \text{Clearance angle}) \\ &= 90^\circ - (7,12^\circ + 3^\circ) \checkmark \\ &= 79,88^\circ \text{ OR } 79^\circ 53' \checkmark\end{aligned}$$

(2)

10.2.4 **Following angle:**

$$\begin{aligned}\text{Following angle} &= 90^\circ + (\text{Helix angle} - \text{Clearance angle}) \\ &= 90^\circ + (7,12^\circ - 3^\circ) \checkmark \\ &= 94,12^\circ \text{ OR } 94^\circ 7' \checkmark\end{aligned}\quad (2)$$

10.3 **ISO V-screw thread:**

- A. Helix angle ✓
- B. Pitch / Lead ✓
- C. Root ✓

(3)
[18]

QUESTION 11: SYSTEMS AND CONTROL (DRIVE SYSTEMS) (SPECIFIC)**11.1 Hydraulic systems :****11.1.1 Area of Ram:**

$$A(\text{Ram}) = \frac{\pi D^2}{4}$$

$$A = \frac{\pi (0,110)^2}{4} \checkmark$$

$$A = 0,0095 \text{ m}^2 \checkmark \text{ OR } 9,50 \times 10^{-3} \text{ m}^2 \checkmark \quad (2)$$

11.1.2 Applied force on plunger:

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

$$\frac{f}{a} = \frac{F}{A} \checkmark$$

$$f = \frac{F \times a}{A}$$

$$f = \frac{350 \times 0,005}{0,0095} \checkmark$$

$$f = 184,21 \text{ N} \checkmark \quad (3)$$

11.1.3 Displacement h:

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

$$a \times h = A \times H$$

$$h = \frac{A \times H}{a} \quad \checkmark$$

$$h = \frac{0,0095 \times 0,025}{0,005} \quad \checkmark$$

$$h = 0,0475 \text{ m}$$

$$h = 47,5 \text{ mm} \quad \checkmark$$

(3)

11.2 Pressure gauge:

- To adjust pressure control valves. ✓
- Determining the pressure being exerted. ✓
- For safety. ✓
- Indicates if leakages are present in the system. ✓

(Any 2 x 1)

(2)

11.3 Advantages of pneumatics:

- Pneumatic tools are very environmentally friendly. / Clean operation ✓
- Last longer. ✓
- More robust. ✓
- More compact. ✓
- Easily maintained. ✓
- Easily installed. ✓
- Cost effective. ✓
- Safe to use. ✓
- High power-to-weight ratio. ✓
- Simple control. ✓
- Quick response. ✓
- Versatile. ✓

(Any 1 x 1)

(1)

11.4 Belt drive:**11.4.1 The rotational frequency in r/sec:**

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

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

$$N_{DN} = \frac{25 \times 75}{350} \quad \checkmark$$

$$N_{DN} = 5,36 \text{ r / sec} \quad \checkmark \quad (4)$$

11.4.2 Belt speed:

$$\begin{aligned} \text{Belt Speed}(V) &= \pi D_{DR} \times N_{DR} \\ &= \pi \times 0,075 \times 25 \quad \checkmark \quad \text{OR} \\ &= 5,89 \text{ m/s} \quad \checkmark \end{aligned} \quad \begin{aligned} \text{Belt Speed}(V) &= \pi D_{DN} \times N_{DN} \\ &= \pi \times 0,350 \times 5,36 \quad \checkmark \\ &= 5,89 \text{ m/s} \quad \checkmark \end{aligned} \quad (2)$$

11.5 V-Belt:

The slippage of the v-belt. \checkmark (1)

11.6 Gear drives:**11.6.1 The rotational frequency:**

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

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

$$\frac{95}{N_D} = \frac{55 \times 50}{30 \times 25} \quad \checkmark$$

$$N_D = \frac{30 \times 25 \times 95}{55 \times 50} \quad \checkmark$$

$$N_D = \frac{71250}{2750}$$

$$N_D = 25,91 \text{ r / min} \quad \checkmark$$

(4)

11.6.2 **Power transmitted:**

$$\text{Power}(P) = \frac{2\pi N T}{60}$$

$$P = \frac{2 \times \pi \times 95 \times 120}{60} \checkmark$$

$$P = 1193,81 \checkmark \text{ Watt(W)} \checkmark$$

OR

$$P = 1,19 \checkmark \text{ Kilowatt(kW)} \checkmark$$

(3)

11.7 **Length of spanner:**

Torque(T) Force Radius

$$\text{Radius} = \frac{T}{F} \checkmark$$

$$\text{Radius} = \frac{135}{300} \checkmark$$

$$\text{Radius} = 0,45 \text{ m} \checkmark$$

OR

$$\text{Radius} = 450 \text{ mm} \checkmark$$

(3)

[28]**TOTAL: 200**