basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATIONS/
NATIONAL SENIOR CERTIFICATE EXAMINATIONS

MECHANICAL TECHNOLOGY: FITTING AND MACHINING

2021

MARKING GUIDELINES

MARKS: 200

These marking guidelines consist of 25 pages.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS (GENERIC)

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

QUESTION 2: SAFETY (GENERIC)

2.1 **First aid basic treatment:**

- Examination ✓
- Diagnosis ✓
- Treatment ✓

(3)

2.2 **Drill press (Already been switched on):**

- Never leave the drill unattended while in motion. ✓
- Switch off the drill when leaving. ✓
- Use a brush or wooden rod to remove chips. ✓
- When reaching around a revolving drill, be careful that your clothes do not get caught in the drill or drill chuck. ✓
- Don't stop a revolving chuck with your hand. ✓
- Don't adjust the drill while working. ✓
- Don't open any guard while in motion. ✓
- Keep hands away from action points. ✓
- Do not force the drill bit into the material. ✓
- Apply cutting fluid if required. ✓

(Any 2 x 1) (2)

2.3 **Isolation of electrode holder:**

To prevent electric shock. ✓ (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. ✓
- Reduction in manufacturing costs. ✓

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

QUESTION 3: MATERIALS (GENERIC)

3.1 **Heat-treatment:**

- Heat the metal slowly to a certain temperature. ✓
- Soak the metal for a certain period to ensure a uniform temperature. ✓
- Cool the metal at a certain rate to room temperature. ✓ (3)

3.2 **Quenching mediums:**

- Water ✓
- Brine ✓
- Liquid salts ✓
- Oil ✓
- Soluble oil and water ✓
- Sand ✓
- Molten lead ✓
- Air ✓
- Lime ✓

(Any 3 x 1) (3)

3.3 **Annealing:**

- To relieve internal stresses of the steel ✓
- Soften steel to make machining possible ✓
- Make steel ductile ✓
- Refine grain structure ✓
- Reduce brittleness ✓

(Any 1 x 1) (1)

3.4 **Carbon steels:**

- Low carbon steel ✓
- Medium carbon steel ✓
- High carbon steel ✓ (3)

3.5 **Iron-carbon equilibrium diagram:**

A Percentage carbon / carbon content ✓
B Temperature in °C ✓
C AC3 line / Higher critical temperature ✓
D AC1 line / Lower critical temperature ✓ (4)

[14]

QUESTION 4: MULTIPLE-CHOICE QUESTIONS (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	B ✓	(1)
4.12	B ✓	(1)
4.13	A ✓	(1)
4.14	D ✓	(1)
		[14]

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

5.1 **Disadvantages of compound slide method:**

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

(Any 3 x 1) (3)

5.2 **Taper calculations:**

5.2.1 **Diameter of taper:**

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

$$\tan\frac{10}{2} = \frac{165 - d}{2 \times 210} \checkmark$$

$$420 \overset{\checkmark}{\tan 5^\circ} = \overset{\checkmark}{165 - d}$$

$$d = 165 - 36{,}75$$

$$d = 128{,}25\ \text{mm} \checkmark$$

(4)

5.2.2 **Tailstock set-over:**

$$x = \frac{L\,(D - d)}{2 \times l} \checkmark$$

$$x = \frac{325\,(165 - 128{,}25)}{2 \times 210} \checkmark$$

$$x = 28{,}44\ \text{mm} \checkmark$$

(3)

5.3 **Calculation of parallel key:**

5.3.1

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

$$= \frac{55}{4} \checkmark$$

$$= 13{,}75\ \text{mm} \checkmark$$

(2)

5.3.2

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

$$= \frac{55}{6} \checkmark$$

$$= 9{,}17\ \text{mm} \checkmark$$

(2)

5.3.3 $\text{Lenght} = 1{,}5 \times \text{diameter of shaft}$

$= 1{,}5 \times 55$ ✓

$= 82{,}5\ \text{mm}$ ✓ (2)

5.4 **Advantages of up-cut milling:**

- Heavier cuts can be taken. ✓
- When hard steels are cut, the total cutting pressure is absorbed by the material at the back of the edge. ✓
- When milling material with a hard scale, the cut is started under the scale where material is softer, extending the life of the cutter. ✓
- A courser feed can be used. ✓
- The strain on the cutter and arbor is less. ✓
- Less vibration experienced on machine. ✓

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

QUESTION 6: TERMINOLOGY (INDEXING) (SPECIFIC)

6.1 **Gear calculations:**

6.1.1 **Number of teeth:**

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

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

$$= \frac{136}{4}$$

$$= 34 \text{ teeth} \checkmark$$

(2)

6.1.2 **Dedendum:**

$$\text{Dedendum} = 1{,}157(m)$$
$$= 1{,}157 \times 4 \checkmark$$
$$= 4{,}63 \text{ mm} \checkmark$$

OR

$$= 1{,}25(m)$$
$$= 1{,}25 \times 4 \checkmark$$
$$= 5 \text{ mm} \checkmark$$

(2)

6.1.3 **Outside diameter:**

$$OD = PCD + 2(m)$$
$$= 136 + 2(4) \checkmark$$
$$= 144 \text{ mm} \checkmark$$

OR

$$= m(T + 2)$$
$$= 4(34 + 2) \checkmark$$
$$= 144 \text{ mm} \checkmark$$

(2)

6.1.4 **Circular pitch:**

$$CP = m \times \pi$$
$$= 4 \times \pi \checkmark$$
$$= 12{,}57 \text{ mm} \checkmark$$

(2)

6.2 **Dove tail calculations:**

w = 190 – 2(DE)

M = w + 2 (AC) + 2 (R) **or** M = w + 2 (AC +R)

6.2.1 **Minimum width of dove tail (w):**

Calculate DE:

$\tan\alpha = \frac{DE}{AD}$ ✓

$DE = AD\tan\alpha$

$= 38\tan 30^\circ$ ✓

$= 21{,}94\text{ mm}$ ✓

OR

$\tan\theta = \frac{AD}{ED}$ ✓

$\tan 60^\circ = \frac{38}{ED}$

$ED = \frac{38}{\tan 60^\circ}$ ✓

$= 21{,}94\text{mm}$ ✓

$w = 190 - 2(DE)$ ✓

$= 190 - 2(21{,}94)$ ✓

$= 190 - 43{,}88$

$= 146{,}12\text{ mm}$ ✓ (6)

6.2.2 **Distance over the rollers (M):**

Calculate AC:

$\tan\alpha = \frac{BC}{AC}$ ✓

$AC = \frac{BC}{\tan\alpha}$ ✓

$= \frac{15}{\tan 30^\circ}$

$= 25{,}98\text{mm}$ ✓

OR

$\tan\theta = \frac{CA}{BC}$ ✓

$CA = BC\tan\theta$ ✓

$= 15\tan 60^\circ$

$= 25{,}98\text{ mm}$ ✓

$M = w + 2(AC) + 2(R)$ ✓

$= 146{,}12 + 2(25{,}98) + 2(15)$ ✓

$= 146{,}12 + 51{,}96 + 30$

$= 228{,}08\text{ mm}$ ✓

OR

$M = w + 2(AC + R)$ ✓

$= 146{,}12 + 2(25{,}98 + 15)$ ✓

$= 146{,}12 + 81{,}96$

$= 228{,}08\text{ mm}$ ✓ (6)

6.3 **Milling of spur gear:**

6.3.1 **Indexing:**

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

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

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

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

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

Approximate indexing:

No full turns and 6 holes on a 24-hole circle ✓

OR

No full turns and 7 holes on a 28-hole circle ✓ (3)

6.3.2 **Change gears:**

$$\frac{D_{DR}}{D_{DN}} = (A - n) \times \frac{40}{A}$$

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

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

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

$$= \frac{3}{4} \times \frac{8}{8} \checkmark$$

$$\frac{D_{DR}}{D_{DN}} = \frac{24 \checkmark}{32 \checkmark}$$

(5)
[28]

QUESTION 7: TOOLS AND EQUIPMENT (SPECIFIC)

7.1 **Reading:**

Reading = 7,90 mm ✓ ✓ (2)

7.2 **Brinell hardness test:**

- Select the desired load to apply to the specimen. ✓
- The specimen is raised to be in contact with the Brinell ball by turning the hand wheel. ✓
- The load is then applied for about 15 - 30 seconds ✓
- Release the load from the specimen. ✓
- Measure the diameter of the impression. ✓
- Determine the Brinell hardness number. ✓ (6)

7.3 **The tensile tester:**

- Yield stress ✓
- Ultimate / maximum tensile stress ✓
- Elongation percentage ✓
- Break stress ✓
- Limit of proportionality ✓
- Elastic limit ✓
- Strain ✓
- Ductility ✓

(Any 3 x 1) (3)

7.4 **Screw thread micrometer:**

Identify:

7.4.1 Screw thread micrometer ✓ (1)

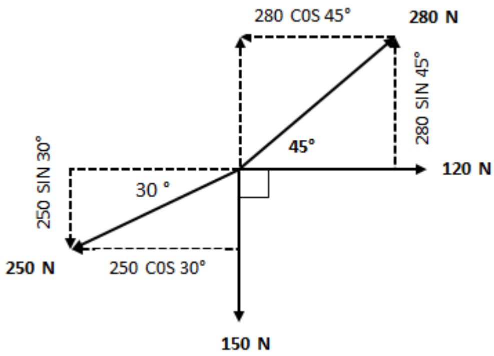
Function:

7.4.2 Measure the pitch diameter ✓ of a screw thread. (1)

[13]

QUESTION 8: FORCES (SPECIFIC)

8.1 **Magnitude and direction of the equilibrant:**



8.1.1 **Sum of the horizontal components (HC):**

$$\sum HC = 280\cos45^\circ \checkmark + 120\cos0^\circ \checkmark - 150\cos90^\circ - 250\cos30^\circ \checkmark$$
$$= 197{,}99 + 120 - 0 - 216{,}51$$
$$= 101{,}48 \text{ N} \checkmark$$

OR

Force	HC (x)	Total
120 N	120cos0º ✓	120N
280 N	280cos 45º ✓	197,99 N
250 N	250cos 210º ✓	-216,51 N
150 N	150cos 270º	0 N
	Total:	101,48 N ✓

(4)

8.1.2 **Sum of the vertical components (VC):**

$$\sum VC = 280\sin45^\circ \checkmark + 120\sin0^\circ - 150\sin90^\circ \checkmark - 250\sin30^\circ \checkmark$$
$$= 197{,}99 + 0 - 150 - 125$$
$$= -77{,}01 \text{ N} \checkmark$$

OR

Force	VC (y)	Total
120 N	120 sin0º	0N
280 N	280sin45º ✓	197,99 N
250 N	250sin210º ✓	-125 N
150 N	150sin270º ✓	-150 N
	Total:	-77,01 N ✓

(4)

8.1.3 **Magnitude of the equilibrium force:**

$E^2 = VC^2 + HC^2$ ✓

$E = \sqrt{(77,01)^2 + (101.48)^2}$ ✓

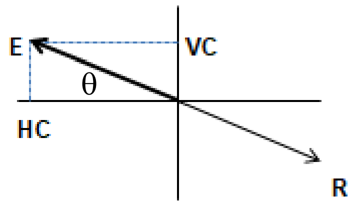
$= 127,39\ N$ ✓ (3)

8.1.4 **Direction of the equilibrium force:**

$\tan\theta = \frac{VC}{HC}$ ✓

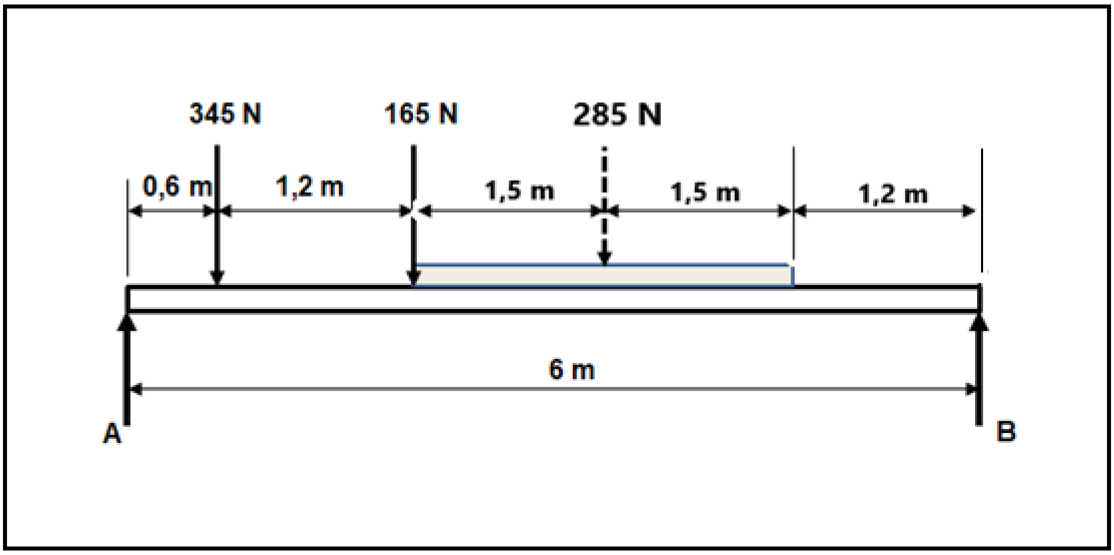
$\tan\theta = \frac{77,01}{101,48}$

$\theta = 37,19°$ ✓



E = 127,39 N at 37,19° N of W ✓ (3)

8.2 **Magnitudes of the reactions in supports A and B:**



Calculate A:
Take moments about B:

$$\sum CWM = \sum ACM$$
$$A \times 6 = (285 \times 2{,}7) + (165 \times 4{,}2) + (345 \times 5{,}4) \checkmark$$
$$A \times 6 = 769{,}5 + 693 + 1863 \checkmark$$
$$A \times 6 = 3325{,}5$$
$$A = \frac{3325{,}5}{6} \checkmark$$
$$A = 554{,}25\ N \checkmark$$

Calculate B:
Take moments about A:

$$\sum CWM = \sum ACM$$
$$(345 \times 0{,}6) + (165 \times 1{,}8) + (285 \times 3{,}3) = 6 \times B \checkmark$$
$$207 + 297 + 940{,}5 = 6 \times B \checkmark$$
$$1444{,}5 = 6 \times B$$
$$\frac{1444{,}5}{6} = B \checkmark$$
$$240{,}75\ N = B \checkmark$$

(8)

8.3 **Stress and Strain:**

8.3.1 **The resistance area of the bush:**

$$A = \frac{\pi(D^2 - d^2)}{4}$$

$$A = \frac{\pi(0{,}058^2 - 0{,}042^2)}{4} \checkmark$$

$$A = 1{,}26 \times 10^{-3}\ m^2 \checkmark$$

(2)

8.3.2 **The stress in the material**:

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

$$= \frac{50 \times 10^3 \checkmark}{1{,}26 \times 10^{-3} \checkmark}$$

$$= 39682539{,}68\ Pa$$

$$= 39{,}68\ MPa \checkmark$$

(3)

8.3.3 **Strain:**

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

$$= \frac{0{,}975 \checkmark}{68 \checkmark}$$

$$= 14{,}34 \times 10^{-3} \checkmark$$

(If any unit indicated, then NO mark for final answer) (3)

8.3.4 **Young's modulus:**

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

$$= \frac{39{,}68 \times 10^6 \checkmark}{14{,}34 \times 10^{-3} \checkmark}$$

$$= 2{,}77 \times 10^9\ Pa \checkmark$$

$$= 2{,}77\ GPa$$

(3)

[33]

QUESTION 9: MAINTENANCE (SPECIFIC)

9.1 **Lack of preventative maintenance:**

- Risk of injury or death. ✓
- Financial loss. ✓
- Damage to parts. ✓
- Loss of production time. ✓

(Any 2 x 1) (2)

9.2 **Malfunctioning of chain drives:**

- Uncovered chain drives not cleaned. ✓
- Tensioning device is not working efficiently. ✓
- Chain is not inspected regularly for elongation. ✓
- Chain drive is not aligned. ✓
- Wear and tear of chain. ✓
- Wear of sprocket teeth. ✓
- Lack of lubrication. ✓
- Chain drive has been overloaded. ✓

(Any 2 x 1) (2)

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

- Checking and replacement of lubrication levels. ✓
- Ensuring that gears are properly secured to shaft. ✓
- Cleaning and replacement of oil filter. ✓
- Reporting excessive noise, wear, vibration and overheating for expert attention. ✓
- Cleaning of gears regularly. ✓

(Any 2 x 1) (2)

9.4 **Property of materials:**

9.4.1 **Polyvinyl chloride (PVC):**

- Can be re-heated and re-shaped ✓
- Flexible ✓
- Rubber like substance and makes a dull sound when dropped.✓
- Can be modified to suit most applications. ✓
- Can be welded (plastic welding). ✓
- Can be bonded with an adhesive. ✓
- Weather resistant ✓
- Water proof ✓
- Easy to work with. ✓
- Light weight ✓
- Recyclable ✓
- Corrosion resistant ✓

(Any 2 x 1) (2)

9.4.2 **Carbon fibre:**

- Cannot be re-heated and re-shaped ✓
- Tough and strong material. ✓
- Light weight ✓
- Weather resistant ✓
- Heat resistant ✓
- Enhance strength of plastic by entrenchment. ✓
- Highly electrically conductive ✓

(Any 2 x 1) (2)

9.4.3 **Bakelite:**

- Electrically non-conductor (electrical insulator) ✓
- Heat resistant ✓
- Well moulded into specific shapes ✓
- Weather resistant ✓
- Cannot be re-heated and re-shaped ✓

(Any 2 x 1) (2)

9.5 **Thermoplastic composites or thermo-hardened (thermosetting) composites:**

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

9.5.2 **Glass fibre:**
Thermo-hardened/Thermosetting ✓ (1)

9.5.3 **Carbon fibre:**
Thermo-hardened/Thermosetting ✓ (1)

9.6 **Uses of materials.**

9.6.1 **Teflon:**

- Orthopaedic and prosthetic appliances ✓
- Hearing aids ✓
- Joints ✓
- Upholstery ✓
- Mechanical parts (e.g., taps and bearings) ✓
- Electrical insulation ✓
- Non-stick coatings ✓

(Any 1 x 1) (1)

9.6.2 **Carbon fibre:**

- Sporting and leisure equipment like: Tennis rackets, squash rackets, badminton rackets, golf clubs, hockey sticks ✓
- Model airplanes ✓
- Bicycle frames ✓
- Ski's ✓
- Surf boards ✓
- Boat masts ✓
- Compressor blades ✓
- Self- lubricating gears ✓
- Artificial satellites ✓
- Helicopter blades ✓
- Car bodies
- Airplane parts (fuselage) ✓

(Any 1 x 1) (1)

9.6.3 **Nylon:**

- Bushes ✓
- Gears ✓
- Pulleys ✓
- Fishing line ✓
- Ropes ✓

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

QUESTION 10: JOINING METHODS (SPECIFIC)

10.1 **Square Thread:**

10.1.1 **Mean diameter:**

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

$$= \frac{40}{2} \checkmark$$

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

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

$$= 85 - \frac{20}{2} \checkmark$$

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

(4)

10.1.2 **Helix angle of the thread:**

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

$$= \frac{40}{\pi \times 75} \checkmark$$

$$\theta = \tan^{-1}(0{,}169765272) \checkmark \checkmark$$

$$= 9{,}63^\circ \text{ or } 9^\circ 38' \checkmark$$

(4)

10.1.3 **Leading tool angle:**

$$\text{Leading tool angle} = 90^\circ - (\text{helix} + \text{clearance angle})$$

$$= 90^\circ - (9{,}63^\circ + 3^\circ) \checkmark$$

$$= 77{,}37^\circ \text{ or } 77^\circ 22' \checkmark$$

(2)

10.1.4 **Following tool angle:**

$$\text{Following tool angle} = 90^\circ + (\text{helix angle} - \text{clearance angle})$$

$$= 90^\circ + (9{,}63^\circ - 3^\circ) \checkmark$$

$$= 96{,}63^\circ \text{ or } 96^\circ 38' \checkmark$$

(2)

10.2 **Screw thread label:**

A. Pitch diameter/mean/effective ✓
B. Helix angle ✓
C. Pitch / Lead ✓
D. Root/Root length ✓ (4)

10.3 **Uses of square thread:**

- Vice screws ✓
- Brake screws ✓
- Lead screws of lathe machines ✓
- Scissor jacks ✓
- Milling machine table feed screws ✓
- Hydraulic jacks (Adjustable top) ✓

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

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

11.1 **Hydraulic calculations:**

11.1.1 **The fluid pressure in MPa:**

Area:

$$A_A = \frac{\pi D_A^2}{4}$$

$$= \frac{\pi (0{,}025)^2}{4} \checkmark$$

$$= 0{,}49 \times 10^{-3}\ m^2 \quad \text{OR} \quad 4{,}9\ 1 \times 10^{-4}\ m^2 \checkmark$$

Pressure:

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

$$= \frac{1{,}32 \times 10^3}{0{,}49 \times 10^{-3}} \checkmark$$

$$= 2{,}69 \times 10^6\ Pa$$

$$= 2{,}69\ MPa \checkmark$$

(4)

11.1.2 **The diameter of piston B:**

$$P_B = P_A$$

$$\frac{F_B}{A_B} = \frac{F_A}{A_A}$$

$$\frac{6,45 \times 10^3}{A_B} = \frac{1,32 \times 10^3}{0,49 \times 10^{-3}} \checkmark$$

$$\frac{6,45 \times 10^3}{A_B} = 2,69 \times 10^6$$

$$A_B = \frac{6,45 \times 10^3}{2,69 \times 10^6} \checkmark$$

$$A_B = 2,40 \times 10^{-3} \checkmark$$

$$A_B = \frac{\pi D_B{}^2}{4}$$

$$D_B = \sqrt{\frac{4A_B}{\pi}} \checkmark$$

$$= \sqrt{\frac{4(2,40 \times 10^{-3})}{\pi}} \checkmark$$

$$= 0,05528\,m$$

$$= 55,28\,mm \checkmark$$

(6)

11.2 **Advantages of chain drive system over belt drive systems:**

- No slipping or creep occurs. ✓
- Higher efficiency. ✓
- Longer life span. ✓
- Does not generate heat. ✓
- Does not undergo the same degrading effects of what time has on belts. ✓
- Much stronger. ✓
- Faster speeds can be obtained. ✓

(Any 2 x 1) (2)

11.3 **Functions of hydraulic reservoir:**

- A fluid storage tank. ✓
- Promotes air separation from the fluid. ✓
- Support for the pump and electric motor. ✓
- Promotes heat dispersion. ✓
- Acts as a base plate for mounting control equipment. ✓
- It allows for expansion or contraction of the hydraulic system. ✓

(Any 2 x 1) (2)

11.4 **Application for hydraulic systems:**

- Machine tools ✓
- Clutch systems ✓
- Brake systems ✓
- Aircraft ✓
- Jacks ✓
- Missiles ✓
- Ships ✓
- Earth moving equipment ✓
- Punch machines ✓
- Turbines ✓
- Tractor lifts ✓
- Car lifts ✓
- Machine vices ✓
- Jaws of life ✓
- Trains ✓

(Any 1 x 1) (1)

11.5 **Belt drive:**

11.5.1 **Rotational frequency:**

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

$$N_{DR} \times 95 = 85 \times 255 \ \checkmark$$

$$N_{DR} = \frac{85 \times 255}{95} \ \checkmark$$

$$N_{DR} = 228{,}16 \text{ r/min}$$

OR

$$N_{DR} = 3{,}8 \text{ r/sec} \ \checkmark$$

(3)

11.5.2 **Speed ratio:**

$$\text{Speed ratio} = \frac{\text{Diameter of driven pulley}}{\text{Diameter of driver pulley}}$$

$$\text{Speed ratio} = \frac{255 \checkmark}{95 \checkmark}$$

$$\text{Speed ratio} = 2{,}68 : 1 \checkmark$$

OR

$$\text{Speed ratio} = \frac{\text{Frequency of driven pulley}}{\text{Frequency of driver pulley}}$$

$$\text{Speed ratio} = \frac{228 \checkmark}{85 \checkmark}$$

$$\text{Speed ratio} = 2{,}68 : 1 \checkmark$$

(3)

11.6 **Gear drive:**

11.6.1 **Rotation frequency:**

$$\frac{N_A}{N_F} = \frac{\text{Product of the number of teeth on driven gears}}{\text{Product of the number of teeth on driving gears}}$$

$$\frac{N_F}{N_A} = \frac{\text{Product of the number of teeth on driving gears}}{\text{Product of the number of teeth on driven gears}}$$

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

$$= \frac{30 \times 20 \times 50 \times 2500 \checkmark}{40 \times 60 \times 70 \checkmark}$$

$$= 446{,}43 \text{ r/min}$$

OR

$$= 7{,}44 \text{ r/sec} \checkmark$$

(4)

11.6.2 **Gear ratio:**

$$\text{Gear Ratio} = \frac{\text{Product of the number of teeth on driven gears}}{\text{Product of the number of teeth on driving gears}}$$

$$= \frac{40 \times 60 \times 70 \checkmark}{30 \times 20 \times 50 \checkmark}$$

$$= \frac{168000}{30000}$$

$$= 5{,}6 : 1 \checkmark$$

OR

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

$$= \frac{2500 \checkmark}{446{,}43 \checkmark}$$

$$= 5{,}6 : 1 \checkmark$$

(3)
[28]

TOTAL: 200