



basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

**SENIOR CERTIFICATE/
NATIONAL SENIOR CERTIFICATE**

GRADE 12

MECHANICAL TECHNOLOGY: FITTING AND MACHINING

NOVEMBER 2020

MARKING GUIDELINES

MARKS: 200

This marking guideline consist of 23 pages.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS (GENERIC)

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



QUESTION 2: SAFETY (GENERIC)**2.1 Work procedures on machine:**

Switch off machine. ✓

(1)

2.2 The horizontal band saw:

- No adjustments to machine or work piece. ✓
- Ensure sufficient coolant on work piece and blade. ✓
- Do not leave machine unattended while in operation. ✓
- Do not lean on machine. ✓
- Keep hands clear from blade. ✓

(Any 2 x 1)

(2)

2.3 Surgical gloves:

- Prevent contamination of wound ✓
- To prevent transmission of HIV/AIDS or any blood related diseases to the first aid helper. ✓

(2)

2.4 Personal protective equipment (PPE) during arc welding:

- Welding helmet / Helmet ✓
- Safety goggles / Face shield ✓
- Leather apron / Apron ✓
- Leather gloves / Gloves ✓
- Leather spat / Spats ✓
- Safety boots / Safety shoes ✓
- Over-all ✓
- Skull cap ✓
- Neck protection ✓
- Ear plugs / Ear muffs. ✓
- Respirator ✓

**(Any 2 x 1)**

(2)

2.5 Responsibility of the employer regarding the health and safety:

- Sufficient lighting ✓✓
- Sufficient ventilation ✓✓
- Provide first-aid equipment ✓✓
- Provide a safe / clean working environment ✓✓
- Provide personal protective equipment (PPE) ✓✓
- Provide safety training to employees ✓✓

(Any 1 x 2)

(2)

2.6 Responsible for administering first aid:

A qualified / trained first aid person ✓

(1)

[10]

QUESTION 3: MATERIALS (GENERIC)

3.1 Tests to identify various metals:

3.1.1 Sound test:

- Tapping the metal with a hammer (any metal object) ✓ and identify the sound. ✓
- Dropping the metal on the floor ✓ and identify the sound. ✓

(Any 1 x 2) (2)

3.1.2 File test:

File the metal and pay attention to the bite of the file into the metal. ✓ The bigger the bite the softer the metal. **OR** The smaller the bite the harder the metal. ✓

(2)

3.2 Purpose of heat treatment of steel:

- To change ✓ the properties ✓ of steel.
- To change ✓ the grain structure ✓ of steel.

(Any 1 x 2) (2)

3.3 Purpose of case hardening on steel:

To create a hard / wear resistance surface / case ✓ with a tough core. ✓

(2)

3.4 The tempering process for steel:

- Heat the steel to a temperature (temper colour) below the critical temperature. ✓
- Soak it at that temperature for a period. ✓
- Quench / cool in an appropriate quenching agent. ✓ (water, brine, or oil)

(3)

3.5 THREE factors for heat treatment of steel:

- Heating temperature / Carbon content ✓
- Soaking (Time period at temperature) / Work piece size ✓
- Cooling rate / Quenching rate (Quenching medium) ✓

(3)

[14]

QUESTION 4: MULTIPLE-CHOICE QUESTIONS (SPECIFIC)

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



[14]

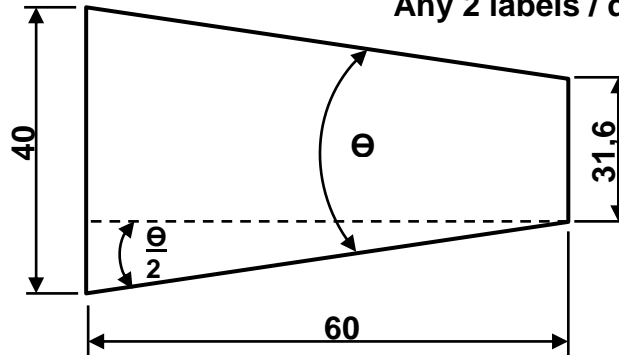
QUESTION 5: TERMINOLOGY (LATHE AND MILLING MACHINE) (SPECIFIC)

5.1 Taper turning:

5.1.1 Taper:

Drawing = ✓

Any 2 labels / dimensions = ✓✓



(3)

5.1.2 Included angle:

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

$$\tan \frac{\theta}{2} = \frac{40-31,6}{2 \times 60} \quad \checkmark$$

$$\frac{\theta}{2} = 4,004^\circ \quad \checkmark$$

$$\theta = 8^\circ \quad \checkmark$$



(4)

5.1.3 Angle of compound slide:

Half the included angle:

$$\frac{\theta}{2} = 4^\circ \quad \checkmark$$

(1)

5.2 Parallel key:

Width:

$$\begin{aligned} \text{Width } W &= \frac{\text{diameter}}{4} \\ &= \frac{30}{4} \quad \checkmark \\ &= 7,5 \text{ mm} \quad \checkmark \end{aligned}$$

Length:

$$\begin{aligned} \text{Length } L &= 1,5 \times \text{diameter} \\ &= 1,5 \times 30 \quad \checkmark \\ &= 45 \text{ mm} \quad \checkmark \end{aligned}$$

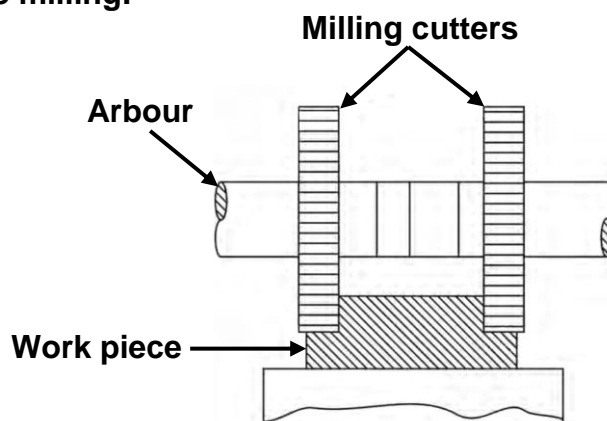
(4)

5.3 **Centring a milling cutter:**

$$\begin{aligned}
 X &= \frac{\text{diameter of workpiece} - \text{thickness of cutter}}{2} \quad \checkmark \\
 &= \frac{60 - 15}{2} \\
 &= \frac{45}{2} \quad \checkmark \\
 &= 22,5 \text{ mm} \quad \checkmark
 \end{aligned}$$

(3)

5.4 **Straddle milling:**



Drawing = ✓
Any 2 labels = ✓✓

(3)
[18]



QUESTION 6: TERMINOLOGY (INDEXING) (SPECIFIC)

6.1 Spur gear terminology:

6.1.1 Outside diameter:

$$\begin{aligned} \text{Outside diameter} &= \text{PCD} + 2m \\ &= mT + 2m \\ &= (3 \times 51) + (2 \times 3) \quad \checkmark \\ &= 153 + 6 \\ &= 159 \text{ mm} \quad \checkmark \end{aligned}$$

OR

$$\begin{aligned} \text{Outside diameter} &= m(T + 2) \\ &= 3(51 + 2) \quad \checkmark \\ &= 3(53) \\ &= 159 \text{ mm} \quad \checkmark \end{aligned}$$

(Any 1 x 2) (2)

6.1.2 Cutting depth:

$$\begin{aligned} \text{Cutting depth} &= 2,157m \\ &= 2,157 \times 3 \quad \checkmark \\ &= 6,471 \text{ mm} \quad \checkmark \end{aligned}$$

OR

$$\begin{aligned} \text{Cutting depth} &= 2,25m \\ &= 2,25 \times 3 \quad \checkmark \\ &= 6,75 \text{ mm} \quad \checkmark \end{aligned}$$

(Any 1 x 2) (2)

6.1.3 Simple indexing:

$$\begin{aligned} \text{Simple Indexing} &= \frac{40}{N} \\ &= \frac{40}{51} \quad \checkmark \\ &\quad \checkmark \quad \checkmark \end{aligned}$$

0 full turns and 40 holes on the 51-hole circle **(3)**

6.2 Differential indexing:

6.2.1 Differential indexing: (Choose 80 divisions)

$$\text{Simple indexing} = \frac{40}{n}$$

$$SI = \frac{40}{83} \quad (\text{indexing not possible, choose 80})$$

$$DI = \frac{40}{80} \quad \checkmark$$

$$= \frac{1}{2} \times \frac{12}{12}$$

$$= \frac{12}{24} \quad \checkmark$$

✓

✓

- No full turns and 12 holes on the 24 hole circle
- No full turns and 14 holes on the 28 hole circle
- No full turns and 15 holes on the 30 hole circle
- No full turns and 17 holes on the 34 hole circle
- No full turns and 19 holes on the 38 hole circle
- No full turns and 21 holes on the 42 hole circle
- No full turns and 23 holes on the 46 hole circle
- No full turns and 27 holes on the 54 hole circle
- No full turns and 29 holes on the 58 hole circle
- No full turns and 31 holes on the 62 hole circle
- No full turns and 33 holes on the 66 hole circle

(Any 1 x 4)

(4)

6.2.2 **Change-gears:**

$$\begin{aligned} \frac{\text{Driver}}{\text{Driven}} &= \frac{A - N}{A} \times \frac{40}{1} \\ &= \frac{80 - 83}{80} \times \frac{40}{1} \quad \checkmark \\ &= \frac{-3}{80} \times \frac{40}{1} \quad \checkmark \\ &= \frac{-120}{80} \\ &= \frac{-12}{8} \times \frac{6}{6} \quad \checkmark \\ &= \frac{-72}{48} \quad \checkmark \end{aligned} \quad \text{OR} \quad \begin{aligned} \frac{\text{Driver}}{\text{Driven}} &= \frac{A - N}{A} \times \frac{40}{1} \\ &= \frac{80 - 83}{80} \times \frac{40}{1} \quad \checkmark \\ &= \frac{-3}{80} \times \frac{40}{1} \quad \checkmark \\ &= \frac{-120}{80} \\ &= \frac{-12}{8} \times \frac{4}{4} \quad \checkmark \\ &= \frac{-48}{32} \quad \checkmark \end{aligned}$$

ALTERNATIVE FORMULA

Change-gears:

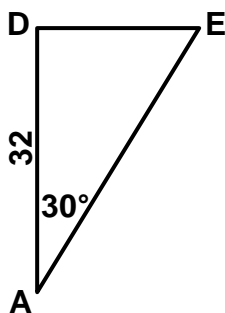
$$\begin{aligned} \frac{\text{Driver}}{\text{Driven}} &= A - N \times \frac{40}{A} \quad \checkmark \\ &= 80 - 83 \times \frac{40}{80} \quad \checkmark \\ &= -3 \times \frac{1}{2} \quad \checkmark \\ &= -\frac{3 \times 24}{2 \times 24} \quad \checkmark \\ &= -\frac{72}{48} \quad \checkmark \end{aligned} \quad \text{OR} \quad \begin{aligned} \frac{\text{Driver}}{\text{Driven}} &= A - N \times \frac{40}{A} \\ &= 80 - 83 \times \frac{40}{80} \quad \checkmark \\ &= -3 \times \frac{1}{2} \quad \checkmark \\ &= -\frac{3 \times 16}{2 \times 16} \quad \checkmark \\ &= -\frac{48}{32} \quad \checkmark \end{aligned}$$

(Any 1 x 5) (5)

6.2.3 **The rotation of the index plate relative to the index crank:**

Index plate rotates in the opposite \checkmark direction to the index crank. (1)

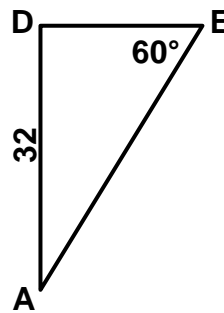
Calculate DE:



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

OR

Calculate DE:



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

Calculate Y:

$$\begin{aligned} Y &= 160 - 2(DE) \quad \checkmark \\ &= 160 - 2(18,48) \\ &= 160 - 36,96 \\ Y &= 123,04 \text{ mm} \quad \checkmark \end{aligned}$$



Calculate X:

$$\begin{aligned} X &= Y + 2(AC + r) \quad \checkmark \\ &= 123,04 + 2(21,65 + 12,5) \quad \checkmark \\ &= 123,04 + 68,3 \\ X &= 191,34 \text{ mm} \quad \checkmark \end{aligned}$$

(9)

6.4 Reasons for balancing a work piece on a lathe:

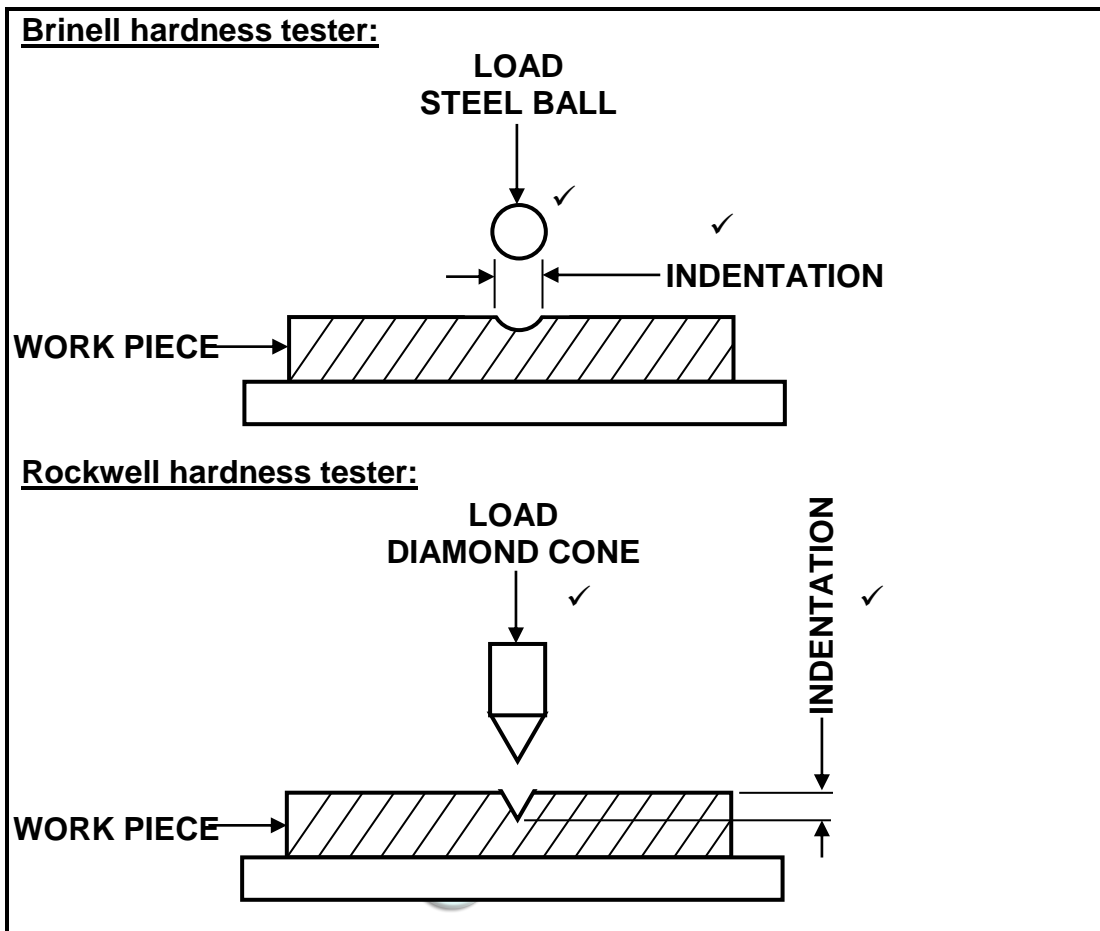
- Prevent unnecessary bearing loads ✓
- Prevent excessive vibration ✓
- To obtain a good finish ✓
- To prevent clatter on the gear teeth ✓
- To prevent the spindle from bending ✓
- To ensure accuracy ✓
- Ensure the safety of the worker ✓
- Prevent damage to the cutting tool / equipment ✓
- Ensure that the work piece is perfectly round ✓
- Prevent work piece from slipping from the chuck ✓

(Any 2 x 1)

(2)
 [28]

QUESTION 7: TOOLS AND EQUIPMENT (SPECIFIC)

7.1



(4)

7.2 **Function of tensile tester:**

To demonstrate the fundamentals / tensile properties ✓ of different materials. ✓

(2)

7.3 **Precision measuring instruments:**

- Outside micrometer ✓
- Inside micrometer ✓
- Depth micrometer ✓

(3)

7.4 **Properties determined by a tensile test:**

- Tensile strength ✓
- Elasticity ✓
- Ductility ✓
- Plasticity ✓
- Strain ✓

(Any 3 x 1)

(3)

7.5 **Measuring instrument for root diameter on a screw thread:**

- Screw thread micro meter ✓
- Vernier calliper ✓

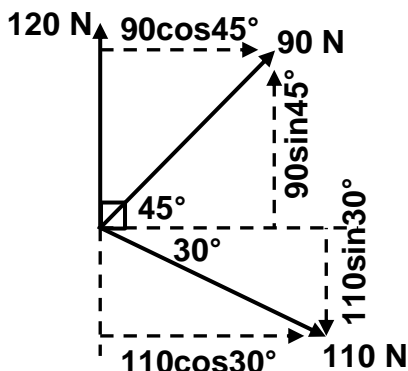
(Any 1 x 1)

(1)

[13]

QUESTION 8: FORCES (SPECIFIC)

8.1 Resultant:



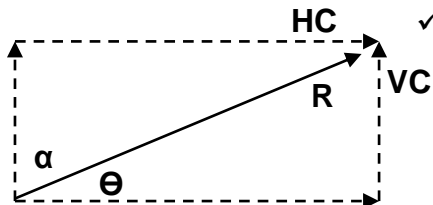
$$\begin{aligned} \Sigma HC &= 90\cos 45^\circ + 110\cos 30^\circ \\ &= 63,64 + 95,26 \\ &= 158,90 \text{ N} \end{aligned}$$

$$\begin{aligned} \Sigma VC &= 120 + 90\sin 45^\circ - 110\sin 30^\circ \\ &= 120 + 63,64 - 55 \\ &= 128,64 \text{ N} \end{aligned}$$

OR

Horizontal components	Magnitudes	Vertical components	Magnitudes
		120	120 N ✓
$90\cos 45^\circ$	63,64 N ✓	$90\sin 45^\circ$	63,64 N ✓
$110\cos 30^\circ$	95,26 N ✓	$-110\sin 30^\circ$	-55 N ✓
TOTAL	158,90 N ✓	TOTAL	128,64 N ✓

$$\begin{aligned} R^2 &= HC^2 + VC^2 \\ R &= \sqrt{158,90^2 + 128,64^2} \\ R &= 204,44 \text{ N} \end{aligned}$$



$$\begin{aligned} \tan \theta &= \frac{VC}{HC} \\ &= \frac{128,64}{158,90} \\ \theta &= 38,99^\circ \text{ or } 38^\circ 59' 24'' \end{aligned}$$

OR

$$\begin{aligned} \tan \alpha &= \frac{HC}{VC} \\ &= \frac{158,90}{128,64} \\ \alpha &= 51,01^\circ \text{ or } 50^\circ 00' 36'' \end{aligned}$$

R = 204,44N at 38,99° north of east ✓

OR

R = 204,44N at 51,01° east of north ✓

Can also state $\cos 330^\circ$ instead of $\cos 30^\circ$ / and $\sin 330^\circ$ instead of $\sin 30^\circ$ (13)

8.2 Moments:

Take moments about "O".

$$\sum RHM = \sum LHM \quad \checkmark$$

$$500 \times "X" = 3000 \times 1,5 \quad \checkmark$$

$$500 \times "X" = 4500$$

$$"X" = \frac{4500}{500} \quad \checkmark$$

$$"X" = 9\text{m} \quad \checkmark$$

(4)

8.3 Stress and Strain:**8.3.1 Type of stress:**Compressive stress \checkmark

(1)

8.3.2 Stress:

$$A = L \times B \quad \checkmark$$

$$= 0,03 \times 0,016 \quad \checkmark$$

$$= 0,48 \times 10^{-3} \text{ m}^2 \quad \checkmark$$

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

$$= \frac{50 \times 10^3}{0,48 \times 10^{-3}}$$

$$\sigma = 104,17 \times 10^6 \text{ Pa} \quad \checkmark$$

$$\sigma = 104,17 \text{ MPa} \quad \checkmark$$

(6)

8.3.3 Change in length:

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

$$\epsilon = \frac{\sigma}{E} \quad \checkmark$$

$$= \frac{104,17 \times 10^6}{90 \times 10^9} \quad \checkmark$$

$$= 1,16 \times 10^{-3} \quad \checkmark$$

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

$$\Delta L = \epsilon \times L \quad \checkmark$$

$$= (1,16 \times 10^{-3}) \times 80 \quad \checkmark$$

$$= 0,09 \text{ mm} \quad \checkmark$$

(6)

8.3.4 **Safe working stress:**

$$\text{Safety factor} = \frac{\text{Break stress}}{\text{Safe working stress}}$$

$$\begin{aligned} \text{Safe working stress} &= \frac{\text{Break stress}}{\text{Safety factor}} \quad \checkmark \\ &= \frac{600}{4} \quad \checkmark \\ &= 150 \text{ MPa} \quad \checkmark \end{aligned}$$

(3)
[33]



QUESTION 9: MAINTENANCE (SPECIFIC)**9.1 Preventative maintenance of a belt drive system:**

- Checking for wear and tear on belt. ✓
- Checking belt alignment. ✓
- Checking the tension setting. ✓
- Checking the tensioning device, e.g. jockeys. ✓
- Checking for wear on the pulleys. ✓
- Checking for wear on pulley bushes. ✓
- Check for dirt on the system. ✓

(Any 3 x 1) (3)**9.2 Results of a lack of preventative maintenance on a gear drive system:**

- A loss / lack of lubrication. ✓
- Loose components. ✓
- Misalignment of gear components. ✓
- Contamination of lubricants. ✓
- Noisy operation. ✓
- Excessive wear on components. ✓
- Excessive vibration in the system. ✓
- Excessive heat generated. ✓
- Malfunctioning of gear system ✓
- Loss of production ✓
- Risk of injuries / death ✓
- Financial loss ✓

**(Any 3 x 1) (3)****9.3 Procedures to reduce wear on a chain drive system:**

- Adjust the chain alignment. ✓
- Adjust the chain tension / mechanism. ✓
- Prevent overloading of the system. ✓
- Keep the sprockets and chain clean. ✓
- Repair or replace worn sprockets and chains. ✓
- Ensure adequate lubrication. ✓

(Any 2 x 1) (2)**9.4 Replace the belt on a flat belt drive system:**

- Switch off the machine ✓
- Release the tension on the belt. ✓
- Remove the belt from the pulleys. ✓
- Fit the correct size replacement belt onto the pulleys. ✓
- Check the pulley's condition and alignment. ✓
- Apply adequate tension to the belt and lock the system. ✓
- Check for proper functioning. ✓

(Any 5 x 1) (5)

9.5 **Properties of Bakelite:**

- Non-conductive (Heat and Electricity) ✓
- Heat-resistant ✓
- Brittle ✓
- Hard ✓
- Can't be deformed by heat (Thermo-hardened / Thermosetting) ✓
- Cast easily ✓
- Resistance to chemicals ✓

(Any 2 x 1) (2)

9.6 **Properties that make Vesconite an outstanding bearing material:**

- Wear resistance / Longer lifespan ✓
- Very versatile ✓
- High load bearing strength / strong ✓
- High temperature limits ✓
- Little to no water absorption ✓
- High chemical resistance ✓
- Very low co-efficient of friction ✓
- Resistance to fuels, oils and hydrocarbons ✓
- Very good machinability ✓
- Tough ✓

(Any 3 x 1) (3)

[18]



QUESTION 10: JOINING METHODS (SPECIFIC)**10.1 Square thread:****10.1.1 The lead of the thread:**

$$\text{Lead} = \text{pitch} \times \text{no of starts}$$

$$= 6 \times 3 \quad \checkmark$$

$$= 18 \text{ mm} \quad \checkmark$$

(2)

10.1.2 The helix angle of the screw thread:

$$\text{Pitch diameter} = \text{OD} - \left(\frac{P}{2}\right)$$

$$= 58 - \frac{6}{2} \quad \checkmark$$

$$= 55 \text{ mm} \quad \checkmark$$

$$\text{Pitch circumference} = \pi \times \text{Pitch diameter}$$

$$= \pi \times 55$$

$$= 172,79 \text{ mm} \quad \checkmark$$

$$\text{Helix angle } \tan\theta = \frac{\text{Lead}}{\text{Pitch circumference}}$$

$$= \frac{18}{172,79} \quad \checkmark$$

$$\theta = 5,95^\circ \text{ or } 5^\circ 57' \quad \checkmark$$

OR

$$\text{Helix angle } \tan\theta = \frac{\text{Lead}}{\pi \times \left(\text{OD} - \frac{P}{2}\right)} \quad \checkmark$$

$$= \frac{18}{\pi \times \left(58 - \frac{6}{2}\right)} \quad \checkmark$$

$$= \frac{18}{\pi \times \left(58 - \frac{6}{2}\right)} \quad \checkmark$$

$$= \frac{18}{172,79} \quad \checkmark$$

$$\theta = 5,95^\circ \text{ or } 5^\circ 57' \quad \checkmark$$

(5)

10.1.3 Leading angle:

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

$$= 90^\circ - (5,95^\circ + 3^\circ) \quad \checkmark$$

$$= 81,05^\circ \quad \checkmark$$

(2)

10.1.4 **Following angle:**

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

= $90^\circ + (5,95^\circ - 3^\circ)$ ✓

= $92,95^\circ$ ✓

(2)

10.2 **M20 x 2,5. Drill size:**

Drill diameter = OD - P ✓

= $20 - 2,5$ ✓

= $17,5 \text{ mm}$ ✓

(3)

10.3 **Pitch of a screw thread:**

The pitch is the axial distance ✓ measured from any given point ✓ on the screw thread to a corresponding point ✓ on an adjacent thread. ✓

(4)

[18]



QUESTION 11: SYSTEMS AND CONTROL (DRIVE SYSTEMS) (SPECIFIC)**11.1 Advantages of a belt drive system compared to a gear drive system:**

- Silent operation ✓
- Cheaper parts ✓
- Transmit power over a longer distance ✓
- Can change direction without additional parts ✓
- Easy to replace parts ✓
- No lubrication needed ✓
- Belt drive slip may prevent system damages or injuries ✓

(Any 2 x 1) (2)**11.2 Belt drive system:****11.2.1 Rotation frequency of driven pulley in r/sec:**

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

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

$$= \frac{1100 \times 0,24}{0,36} \quad \checkmark$$

$$= 733,33 \text{ r/min} \quad \checkmark$$

$$= 12,22 \text{ r/sec} \quad \checkmark$$

(4)**11.2.2 The power transmitted in kW:**

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

$$P = \frac{(200 - 90) \pi \times 0,24 \times 1100}{60} \quad \checkmark$$

$$= 1520,53 \text{ Watt} \quad \checkmark$$

$$= 1,52 \text{ kW} \quad \checkmark$$

OR

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

$$P = \frac{(200 - 90) \pi \times 0,36 \times 733,33}{60} \quad \checkmark$$

$$= 1520,53 \text{ Watt} \quad \checkmark$$

$$= 1,52 \text{ kW} \quad \checkmark$$

(4)

11.2.3 **The belt speed in m.s⁻¹:**

$$V = \frac{\pi DN}{60}$$

$$= \frac{\pi \times 0,24 \times 1100}{60} \checkmark$$

$$= 13,82 \text{ m.s}^{-1} \checkmark$$

$$V = \frac{\pi DN}{60}$$

$$= \frac{\pi \times 0,36 \times 733,33}{60} \checkmark$$

$$= 13,82 \text{ m.s}^{-1} \checkmark$$

OR

(3)

11.3 **Hydraulics:**

11.3.1 **Fluid pressure:**

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

$$A_A = \frac{\pi(0,04)^2}{4} \checkmark$$

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

$$P = \frac{F_A}{A_A}$$

$$P = \frac{80}{0,00126} \checkmark$$

$$P = 63,49 \times 10^3 \text{ Pa} \text{ OR } 63,66 \times 10^3 \text{ Pa} \checkmark$$

$$P = 63,49 \text{ kPa} \text{ OR } 63,66 \text{ kPa}$$

(4)

11.3.2 **Diameter of piston B in millimetres:**

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

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

$$= \frac{320 \times 0,00126}{80} \checkmark$$

$$= 5,04 \times 10^{-3} \text{ m}^2 \checkmark$$

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

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

$$= \sqrt{\frac{(5,04 \times 10^{-3}) \times 4}{\pi}} \checkmark \text{ OR}$$

$$= 0,0801 \text{ m} \checkmark$$

$$= 80,11 \text{ mm} \checkmark$$

Calculation without rounding off:

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

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

$$= \sqrt{\frac{(5,026548246 \times 10^{-3}) \times 4}{\pi}} \checkmark$$

$$= 0,08 \text{ m} \times 1000 \checkmark$$

$$= 80 \text{ mm} \checkmark$$

(7)

11.4 Gear drive system:

Rotation frequency of driven gear:

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

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

$$N_F = \frac{20 \times 18 \times 42}{36 \times 46 \times 80} \times 1440 \quad \checkmark$$

$$= \frac{164,35 \text{ r/min}}{60} \quad \checkmark$$

$$= 2,74 \text{ r/sec} \quad \checkmark$$

OR

$$N_B \times T_B = N_A \times T_A$$

$$N_B \times 36 = 1440 \times 20$$

$$N_B = \frac{1440 \times 20}{36}$$

$$N_B = 800 \text{ r/min} \quad \checkmark$$



$$N_B = N_C$$

$$N_D \times T_D = N_C \times T_C$$

$$N_D \times 46 = 800 \times 18$$

$$N_D = \frac{800 \times 18}{46}$$

$$N_D = 313,04 \text{ r/min} \quad \checkmark$$

$$N_D = N_E$$

$$N_F \times 80 = 313,04 \times 42$$

$$N_F = \frac{313,04 \times 42}{80}$$

$$N_F = \frac{164,35 \text{ r/min}}{60} \quad \checkmark$$

$$N_F = 2,74 \text{ r/sec} \quad \checkmark$$

(4)
[28]
TOTAL: 200