



basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATIONS/ NATIONAL SENIOR CERTIFICATE EXAMINATIONS

MECHANICAL TECHNOLOGY: FITTING AND MACHINING

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MARKING GUIDELINES

MARKS: 200

These marking guidelines consist of 22 pages.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS (GENERIC)

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

QUESTION 2: SAFETY (GENERIC)

2.1 First aid:

- When illness occurs. ✓
- When an injury is sustained. ✓
- When an accident occurs. ✓

(Any 2 x 1) (2)

2.2 Bench grinder:

- A. A fire extinguisher should be readily available. ✓
- B. Safety glasses must be worn. ✓
- C. Maximum grinding wheel speed. ✓
- D. Maximum distance between tool rest and grinding wheel. ✓

(4)

2.3 Drill press:

- Never try to stop/hold the work piece by hand when the drill bit get stuck during drilling. ✓
- Don't force a drill bit into the work piece. ✓
- Keep loose clothing and hair away from revolving parts. ✓
- Never leave the machine running if it is unattended. ✓
- Use a brush or wooden rod to remove chips from the drill. ✓
- Do not put hands near moving parts. ✓
- Never clean or adjust the machine while it is in motion. ✓
- Never try to stop the drill/chuck by hand. ✓

(Any 2 x 1) (2)

2.4 Surface grinder:

- Never clean or adjust the machine while it is in motion. ✓
- Know how to stop the machine in an emergency. ✓
- Do not use excessive force when grinding the work piece. ✓
- Immediately report any dangerous defects of the machine. ✓
- Stop using defective machinery until it has been repaired by a qualified person. ✓
- Ensure that the grinding wheel is not submerged in coolant. ✓
- Never leave the machine running if it is unattended. ✓
- Do not put hands near moving parts. ✓

(Any 2 x 1) (2)

[10]

QUESTION 3: MATERIALS (GENERIC)

3.1 **Critical temperature:**

3.1.1 **Hardening:**
Above ✓ (1)

3.1.2 **Tempering:**
Below ✓ (1)

3.1.3 **Normalising:**
Above ✓ (1)

3.2 **Machining test:**

- The chips heating colour ✓
- The chips curl ✓ (2)

3.3 **Material tests:**

- Sound test ✓
 - Bending test ✓
 - Filing test ✓
 - Hardness test ✓
 - Density test ✓
 - Weight measurement ✓
 - Magnetic test ✓
 - Visual inspection/observation ✓
 - Scratch test ✓
- (Any 3 x 1) (3)

3.4 **Quenching methods:**

- Carburising ✓
 - Nitriding ✓
 - Cyaniding ✓
- (Any 2 x 1) (2)

3.5 **Heat treatment temperature:**

- Pyrometer ✓
 - Crayons ✓
 - Visually ✓
 - Magnet ✓
- (Any 1 x 1) (1)

3.6 **Heat-treatment steps:**

- Heat the metal. ✓
- Soak the metal. ✓
- Cool the metal. ✓ (3)

[14]

QUESTION 4: MULTIPLE-CHOICE QUESTIONS (SPECIFIC)

4.1	B ✓	(1)
4.2	C ✓	(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	A ✓	(1)
4.11	B ✓	(1)
4.12	A ✓	(1)
4.13	A ✓	(1)
4.14	D ✓	(1)
		[14]

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

5.1 Advantages of tailstock set-over method:

- The automatic feed of the machine can be used. ✓
- Good finish. ✓
- Long tapers can be cut. ✓
- Accurate tapers can be cut. ✓
- Experience less operator fatigue. ✓

(Any 2 x 1) (2)

5.2 Taper calculations:

5.2.1 Tool:

Boring bar. ✓

(1)

5.2.2 Diameter of taper:

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

$$\checkmark \tan \frac{7}{2} = \frac{46-d}{2 \times 155} \checkmark$$

OR

$$\tan 3,5 = \frac{x}{155} \checkmark$$

$$x = \tan 3,5 \times 155 \checkmark$$

$$= 9,46 \text{ mm} \checkmark$$

$$310 \tan 3,5^\circ = 46 - d \checkmark$$

$$d = 46 - 18,96$$

$$d = 27,04 \text{ mm} \checkmark$$

$$d = 46 - 2x \checkmark$$

$$= 46 - 2(9,46) \checkmark$$

$$= 27,04 \text{ mm} \checkmark$$

(6)

5.3 Calculation of parallel key:

5.3.1

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

$$= \frac{82}{4} \checkmark$$

$$= 20,50 \text{ mm} \checkmark$$

(2)

5.3.2

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

$$= \frac{82}{6} \checkmark$$

$$= 13,67 \text{ mm} \checkmark$$

(2)

5.3.3 Length = $1,5 \times \text{diameter of shaft}$
 = $1,5 \times 82$ ✓
 = 123 mm ✓ (2)

5.4 **Advantages of gang milling:**

- Several surfaces can be milled simultaneously. ✓
- Saving time. ✓
- Makes production more effective. ✓
- Fewer cutters need to be changed. ✓

(Any 3 x 1) (3)
[18]

QUESTION 6: TERMINOLOGY (INDEXING) (SPECIFIC)

6.1 Gear calculations:

6.1.1 Number of teeth:

$$\begin{aligned} \text{Module} &= \frac{\text{PCD}}{T} \\ T &= \frac{\text{PCD}}{m} \quad \checkmark \\ &= \frac{156}{3} \quad \checkmark \\ &= 52 \text{ teeth} \quad \checkmark \end{aligned} \quad (3)$$

6.1.2 Dedendum:

$$\begin{aligned} \text{Dedendum} &= 1,157(m) &= 1,25(m) \\ &= 1,157 \times 3 \quad \checkmark &\text{OR} &= 1,25 \times 3 \quad \checkmark \\ &= 3,47 \text{ mm} \quad \checkmark &&= 3,75 \text{ mm} \quad \checkmark \end{aligned} \quad (2)$$

6.1.3 Outside diameter:

$$\begin{aligned} \text{OD} &= \text{PCD} + 2(m) &= m(T + 2) \\ &= 156 + 2(3) \quad \checkmark &\text{OR} &= 3(52 + 2) \quad \checkmark \\ &= 162 \text{ mm} \quad \checkmark &&= 162 \text{ mm} \quad \checkmark \end{aligned} \quad (2)$$

6.1.4 Circular pitch:

$$\begin{aligned} \text{CP} &= m \times \pi \\ &= 3 \times \pi \quad \checkmark \\ &= 9,42 \text{ mm} \quad \checkmark \end{aligned} \quad (2)$$

6.2 Dove tail calculations:

$$W = 145 + 2(DE)$$

$$m = W - 2(AC) - 2(R) \text{ or } m = W - 2(AC + R)$$

6.2.1 Maximum width of dove tail (W):

Calculate DE:

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

OR

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

$$\begin{aligned}W &= 145 + 2(DE) \checkmark \\ &= 145 + 2(18,48) \checkmark \\ &= 145 + 36,96 \\ &= 181,96 \text{ mm} \checkmark\end{aligned}$$

(6)

6.2.2 Distance between the rollers (m):

Calculate AC:

$$\begin{aligned}\tan \alpha &= \frac{BC}{AC} \checkmark \\ AC &= \frac{BC}{\tan \alpha} \checkmark \\ &= \frac{12}{\tan 30^\circ} \\ &= 20,78 \text{ mm} \checkmark\end{aligned}$$

OR

$$\begin{aligned}\tan \theta &= \frac{AC}{BC} \checkmark \\ AC &= BC \tan 60^\circ \checkmark \\ &= 12 \tan 60^\circ \\ &= 20,78 \text{ mm} \checkmark\end{aligned}$$

$$\begin{aligned}m &= W - 2(AC) - 2(R) \checkmark \\ &= 181,96 - 2(20,78) - 2(12) \checkmark \\ &= 181,96 - 41,56 - 24 \\ &= 116,40 \text{ mm} \checkmark\end{aligned}$$

OR

$$\begin{aligned}m &= W - 2(AC + R) \checkmark \\ &= 181,96 - 2(20,78 + 12) \checkmark \\ &= 181,96 - 65,56 \\ &= 116,40 \text{ mm} \checkmark\end{aligned}$$

(6)

6.3 Milling of spur gear:

6.3.1 Indexing:

$$\begin{aligned}\text{Indexing} &= \frac{40}{n} \\ \text{Indexing} &= \frac{40}{A} \\ &= \frac{40}{160} \quad \checkmark \\ &= \frac{1}{4} \times \frac{6}{6} \\ &= \frac{6}{24} \quad \checkmark\end{aligned}$$

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:

$$\begin{aligned}\frac{D_{DR}}{D_{DN}} &= (A - n) \times \frac{40}{A} \\ \frac{D_{DR}}{D_{DN}} &= (160 - 163) \times \frac{40}{160} \quad \checkmark \\ &= -3 \times \frac{40}{160} \\ &= \frac{-120}{160} \\ &= \frac{3}{4} \times \frac{8}{8} \quad \checkmark \\ \frac{D_{DR}}{D_{DN}} &= \frac{24}{32} \quad \checkmark\end{aligned}$$

(4)
[28]

QUESTION 7: TOOLS AND EQUIPMENT (SPECIFIC)

- 7.1 **Define hardness:**
Hardness is a material's ability to resist deformation, ✓ usually by indentation/penetration/scratching. ✓ (2)
- 7.2 **Hardness testers:**
- Brinell hardness tester ✓
 - Rockwell hardness tester ✓
 - Vickers hardness tester ✓
- (Any 2 x 1) (2)
- 7.3 **Microscope:**
To measure ✓ the diameter/depth of the indentation ✓ left in the test material. (2)
- 7.4 **Tester:**
- 7.4.1 Tensile tester ✓ (1)
- 7.4.2 Hand wheel ✓ (1)
- 7.5 **Hardness tester:**
Rockwell hardness tester ✓ (1)
- 7.6 **Moment and Force:**
Test the reaction ✓ on either side of simply loaded beam. ✓ (2)
- 7.7 **Reading:**
 $2,00 + 0,40 + 0,5 = 2,90 \text{ mm}$ ✓ ✓ (2)
- [13]**

QUESTION 8: FORCES (SPECIFIC)

8.1 Forces:

8.1.1 Horizontal components:

$$\Sigma HC = 75\cos 35^\circ - 15\cos 45^\circ - 5\cos 0^\circ - 45\cos 60^\circ$$

$$\Sigma HC = 61,44 - 10,61 - 5 - 22,5$$

$$\Sigma HC = 23,33 \text{ N} \checkmark$$

(5)

8.1.2 Vertical components:

$$\Sigma VC = 75\sin 35^\circ + 15\sin 45^\circ - 5\sin 0^\circ - 45\sin 60^\circ$$

$$\Sigma VC = 43,02 + 10,61 - 0 - 38,97$$

$$\Sigma VC = 14,66 \text{ N} \checkmark$$

(4)

OR

Force	θ	8.1.1 $\Sigma HC/x = F\cos\theta$	8.1.2 $\Sigma VC/y = F\sin\theta$
25 N	90°	$HC = 75\cos 35^\circ$	$VC = 75\sin 35^\circ$
40 N	0°	$HC = 15\cos 135^\circ$	$VC = 15\sin 135^\circ$
55 N	290°	$HC = 5\cos 180^\circ$	$VC = 5\sin 180^\circ$
120 N	210°	$HC = 45\cos 240^\circ$	$VC = 45\sin 240^\circ$
		Total 23,33 N \checkmark	14,66 N \checkmark

(9)

8.1.3 Resultant:

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

$$R = \sqrt{(14,66)^2 + (23,33)^2} \checkmark$$

$$R = \sqrt{759,20}$$

$$R = 27,55 \text{ N} \checkmark$$

(2)

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

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

$$\theta = \tan^{-1} \left(\frac{14,66}{23,33} \right) \checkmark \quad \text{OR}$$

$$\theta = \tan^{-1}(0,63)$$

$$\theta = 32,14^\circ \checkmark$$

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

$$\theta = \tan^{-1} \left(\frac{23,33}{14,66} \right) \checkmark$$

$$\theta = \tan^{-1}(1,59)$$

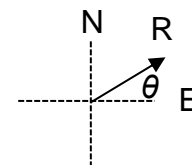
$$\theta = 57,86^\circ \checkmark$$

Direction:

$$R = 27,55 \text{ N } 32,14^\circ \text{ North of East} \checkmark$$

OR

$$R = 27,55 \text{ N } 57,86^\circ \text{ East from North}$$



(3)

8.2 **UDL Beam:**

8.2.1 **Distributed load:**
Uniform distributed load:

$$\text{UDL} = 15 \times 6 \checkmark$$

$$= 90 \text{ N } \checkmark$$

(2)

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

$$\checkmark \quad \checkmark \quad \checkmark$$

$$(160 \times 2,5) + (90 \times 7) + (55 \times 14) = (A \times 14)$$

$$400 + 630 + 770 = 14A$$

$$A = \frac{1800}{14}$$

$$A = 128,57 \text{ N } \checkmark$$

Reaction in support B:
Take moments about A:

$$\checkmark \quad \checkmark$$

$$(B \times 14) = (55 \times 0) + (90 \times 7) + (160 \times 11,5)$$

$$14B = 0 + 630 + 1840$$

$$B = \frac{2470}{14}$$

$$B = 176,43 \text{ N } \checkmark$$

(7)

8.3.1 **Diameter:**

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

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

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

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

$$A = 3,19 \times 10^{-4}$$

OR

$$d = \sqrt{\frac{4 \times (3,19 \times 10^{-4})}{\pi}} \checkmark$$

$$\frac{\pi d^2}{4} = 3,19 \times 10^{-4} \checkmark$$

$$= 0,02015 \text{ m}$$

$$\pi \times d^2 = 1,28 \times 10^{-3}$$

$$= 20,15 \text{ mm} \checkmark$$

$$\sqrt{d^2} = \sqrt{4,06 \times 10^{-4}} \checkmark$$

$$d = 0,02015 \text{ m}$$

$$d = 20,15 \text{ mm} \checkmark$$

(4)

8.3.2 **Change in length:**

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

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

$$\varepsilon = \frac{56,5 \times 10^6}{90 \times 10^9} \checkmark$$

$$\varepsilon = 6,28 \times 10^{-4} \checkmark$$

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

$$\Delta L = \varepsilon \times oL \checkmark$$

$$\Delta L = 6,28 \times 10^{-4} \times 0,275 \checkmark$$

$$\Delta L = 1,73 \times 10^{-4} \text{ m}$$

$$\Delta L = (1,73 \times 10^{-4}) \times 1000$$

$$\Delta L = 0,17 \text{ mm} \checkmark$$

(6)

[33]

QUESTION 9: MAINTENANCE (SPECIFIC)

9.1 Preventative maintenance:

- Checking for wear and tear on belt. ✓
- Checking belt alignment. ✓
- Checking the tensioning devices. ✓
- Checking the tensioning setting. ✓
- Make sure all guards are in place. ✓
- Checking for dirt on belt and pulleys. ✓

(Any 4 x 1) (4)

9.2 High power drives:

- Gear drive ✓
- Multiple belt drives ✓
- Tooth belt drives ✓
- Chain drives ✓

(Any 2 x 1) (2)

9.3 Bonding methods:

- Plastic welding (heat) ✓
- Adhesive/PVC-Weld ✓

(2)

9.4 Uses of the materials:

9.4.1 Nylon:

- Pulleys ✓
- Ropes ✓
- Bushes ✓
- Gears ✓
- Wear pads ✓
- Wheels ✓
- Rollers ✓
- Gaskets ✓
- Seals ✓
- Machinery parts ✓

(Any 2 x 1) (2)

9.4.2 Fibreglass:

- Machine covers ✓
- Roof covering ✓
- Woven cloth ✓

(Any 2 x 1) (2)

9.4.3 **Bakelite uses:**

- Circuit boards ✓
- Electrical components ✓
- Electrical insulators ✓
- Kitchenware ✓
- Jewellery ✓
- Pipe stems ✓
- Toys ✓
- Distributor rotor ✓
- Distributor cap ✓
- Aircraft components ✓
- Bearings ✓
- Clutch linings ✓
- Brake linings ✓
- Laminated materials ✓

(Any 2 x 1) (2)

9.5 **Thermo-hardened/Thermosetting or Thermoplastic composite:**

- | | | |
|-------|-----------------------------------|-----|
| 9.5.1 | Thermoplastic ✓ | (1) |
| 9.5.2 | Thermo-hardened / Thermosetting ✓ | (1) |
| 9.5.3 | Thermo-hardened / Thermosetting ✓ | (1) |
| 9.5.4 | Thermoplastic ✓ | (1) |

[18]

QUESTION 10: JOINING METHODS (SPECIFIC)

10.1 Uses of multiple threads:

- Fire hydrants ✓
- Valves ✓
- Aircraft landing gear ✓
- Industrial machines ✓
- Lids of containers/jars ✓
- Fly press ✓

(Any 3 x 1) (3)

10.2 Multiple screw threads:

- They provide more bearing surface. ✓
- Do not strip easily. ✓
- To provide faster linear movement. ✓
- They are more efficient. ✓
- They lose less power to friction. ✓

(Any 3 x 1) (3)

10.3 Square Thread:

10.3.1 Pitch:

$$\begin{aligned}\text{Pitch} &= \frac{\text{Lead}}{\text{Number of starts}} \\ &= \frac{46}{2} \checkmark \\ &= 23 \text{ mm } \checkmark\end{aligned}$$

(2)

10.3.2 Pitch diameter:

$$\begin{aligned}D_m &= OD - \frac{P}{2} \\ &= 80 - \frac{23}{2} \checkmark \\ &= 68,50 \text{ mm } \checkmark\end{aligned}$$

(2)

10.3.3 Helix angle of the thread:

$$\begin{aligned}\tan \theta &= \frac{\text{Lead}}{\pi \times D_M} \\ &= \frac{46}{\pi \times 68,50} \checkmark \\ \theta &= \tan^{-1}(0,213755544) \checkmark \\ &= 12,07^\circ \text{ or } 12^\circ 4' \checkmark\end{aligned}$$

(4)

10.3.4 **Leading tool angle:**

$$\begin{aligned}\text{Leading tool angle} &= 90^\circ - (\text{helix} + \text{clearance angle}) \\ &= 90^\circ - (12,07^\circ + 3^\circ) \checkmark \\ &= 74,93^\circ \text{ or } 74^\circ 55' \checkmark\end{aligned}\quad (2)$$

10.3.5 **Following tool angle:**

$$\begin{aligned}\text{Following tool angle} &= 90^\circ + (\text{helix} - \text{clearance angle}) \\ &= 90^\circ + (12,07^\circ - 3^\circ) \checkmark \\ &= 99,07^\circ \text{ or } 99^\circ 4' \checkmark\end{aligned}\quad (2)$$

[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:

$$A \text{ (Plunger)} = \frac{\pi d^2}{4}$$

$$A = \frac{\pi(0,03)^2}{4} \checkmark$$

$$A = 0,71 \times 10^{-3} \text{ m}^2 \checkmark$$

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

$$P = \frac{900}{0,71 \times 10^{-3}} \checkmark$$

$$P = 1,27 \times 10^6 \text{ Pa}$$

$$P = 1,27 \text{ MPa} \checkmark$$

(5)

11.1.2 Mass in kg:

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

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

$$F_B = \frac{900 \times 31,42 \times 10^{-3}}{0,71 \times 10^{-3}} \checkmark$$

$$F_B = 39828,17 \text{ N}$$

$$\text{Mass} = 3982,82 \text{ kg OR } 4059,96 \text{ kg} \checkmark$$

(4)

11.2 Function of hydraulic components:

- 11.2.1 **Motor**
Drives the hydraulic pump. ✓ (1)
- 11.2.2 **One-way-valve**
To prevent backflow of hydraulic fluid. ✓ (1)
- 11.2.3 **Reservoir**
Contains the hydraulic fluid. ✓ (1)

11.3 Belt drive:

11.3.1 The rotational frequency in r/sec:

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

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

$$N_{DR} = \frac{5,83 \times 0,5}{0,09} \quad \checkmark$$

$$N_{DR} = \frac{2,92}{0,09}$$

$$N_{DR} = 32,39 \text{ r/sec} \quad \checkmark$$

OR

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

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

$$N_{DR} = \frac{350 \times 500}{90} \quad \checkmark$$

$$N_{DR} = \frac{1944,44 \text{ r/min}}{60}$$

$$N_{DR} = 32,41 \text{ r/sec} \quad \checkmark$$

(3)

11.3.2 **Power transmitted in Watt:**

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

$$P = (1900 - 450) \pi \times 0,09 \times 32,39$$

$$P = 13279,18 \text{ W} \quad \checkmark$$

OR

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

$$P = (1900 - 450) \pi \times 0,5 \times 5,83$$

$$P = 13278,73 \text{ W} \quad \checkmark$$

OR

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

$$P = (1900 - 450) \pi \times 0,5 \times 350$$

$$P = 13286,32 \text{ W} \quad \checkmark$$

(4)

11.4 **Avoid slipping:**

- Adding a belt tensioning device. ✓
- Not subjected to sudden loads. ✓
- Do not overload the drive. ✓
- Cover the drives to guard against dust and fluids. ✓
- Increase the contact area of the belts. ✓
- Use toothed belts and pulleys. ✓

(2)

(Any 2 x 1)

11.5 Gear drive:

11.5.1 Number of teeth:

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

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

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

$$T_D = \frac{3500 \times 33 \times 25}{1050 \times 55} \quad \checkmark$$

$$T_D = 50 \text{ teeth} \quad \checkmark$$

(3)

11.5.2 Torque:

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

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

$$T = \frac{(737,4 \times 10^3) \times 60}{2 \times \pi \times 1050} \quad \checkmark$$

$$T = 6706,33 \text{ Nm} \quad \checkmark$$

OR

$$P = 2 \pi N T$$

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

$$T = \frac{(737,4 \times 10^3)}{2 \times \pi \times 17,5} \quad \checkmark$$

$$T = 6706,33 \text{ Nm} \quad \checkmark$$

(3)

[28]

TOTAL: 200