education

Department:
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GRADE 12

MECHANICAL TECHNOLOGY

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MEMORANDUM

MARKS: 200

This memorandum consists of 16 pages.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS
(Learning Outcome 3: Assessment Standards 1 – 9)

1.1	C √	(1)
1.2	A √	(1)
1.3	D √	(1)
1.4	C√	(1)
1.5	B√	(1)
1.6	D √	(1)
1.7	A √	(1)
1.8	C√	(1)
1.9	C √	(1)
1.10	B √	(1)
1.11	C √	(1)
1.12	D √	(1)
1.13	D √	(1)
1.14	C √	(1)
1.15	A √	(1)
1.16	C √	(1)
1.17	D √	(1)
1.18	C √	(1)
1.19	B √	(1)
1.20	A √	(1)

[20]

QUESTION 2: FORCES AND SYSTEMS AND CONTROL (Learning Outcome 3: Assessment Standards 6 and 8)

2.1 HYDRAULIC SYSTEM

2.1.1 Pressure in the system

$$A_B = \frac{\pi D^2}{4} \quad \surd$$

$$= \frac{\pi(0,1)^2}{4}$$

$$= 7,85 \times 10^{-3}\ m^2 \quad \surd$$

$$P = \frac{F_B}{A_B} \quad \surd$$

$$= \frac{150 \times 10^3}{7,85 \times 10^{-3}}$$

$$= 19,11\ MPa \quad \surd$$

(4)

2.1.2 Force in piston A

$$A_A = \frac{\pi D^2}{4} \quad \surd$$

$$= \frac{\pi(0,25)^2}{4}$$

$$= 0,49 \times 10^{-3}\ m^2 \quad \surd$$

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

$$F_A = P \times A_A$$

$$= 19,11 \times 10^6 \times 0,49 \times 10^{-3} \quad \surd$$

$$= 9,36\ kN$$

(4)

2.1.3 The distance "X"

$$V_A = V_B \quad \surd$$
$$V_B = A_B \times L$$
$$= 7,85 \times 10^{-3} \times 0,01$$
$$= 0,08 \times 10^{-3}\ m^3 \quad \surd$$

$$V_A = A_A \times X \quad \surd$$
$$X = \frac{V_A}{A_A} \quad \surd$$
$$= \frac{0,08 \times 10^{-3}}{0,49 \times 10^{-3}}$$
$$= 0,16\ m \quad \surd$$
$$= 160\ mm$$

(5)

2.2 Forces

2.2.1 The diameter of the brass bar

$$\sigma = \frac{F}{A} \quad \surd$$
$$A = \frac{F}{\sigma}$$
$$= \frac{30 \times 10^3}{6 \times 10^6} \quad \surd$$
$$= 5 \times 10^{-3}\ m^2$$

$$A = \frac{\pi \times D^2}{4} \quad \surd$$
$$D^2 = \frac{A \times 4}{\pi}$$
$$= \sqrt{\frac{A \times 4}{\pi}} \quad \surd$$
$$D = \sqrt{\frac{5 \times 10^{-3} \times 4}{\pi}} \quad \surd$$
$$D = 0,079788\ m$$
$$D = 79,788\ mm$$
$$= 79,79\ mm$$

(6)

2.2.2 The strain

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

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

$$\varepsilon = \frac{6 \times 10^{6}}{90 \times 10^{9}} \quad \surd$$

$$\varepsilon = 6,666 \times 10^{-5} \quad \surd \qquad (3)$$

2.2.3 The change in length

$$\varepsilon = \frac{\Delta l}{ol} \quad \surd$$

$$\Delta l = \varepsilon \times ol \quad \surd$$

$$\Delta l = \left(6,666 \times 10^{-5}\right) \times 250 \quad \surd$$

$$\Delta l = 16,67 \times 10^{-3}\ mm \qquad (3)$$

2.3 Belt drives (Diameter of the pump pulley)

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

$$= \frac{1\,440 \times 100}{3\,000} \quad \surd$$

$$= 48\ mm \quad \surd \qquad (3)$$

2.4 Wheel and axle

2.4.1 Mechanical Advantage

$$MA = \frac{load}{effort} \quad \surd$$

$$MA = \frac{800}{56} \quad \surd$$

$$= 14,3 \quad \surd \qquad (4)$$

2.4.2 Velocity Ratio/Displacement ratio

$$VR = \frac{2D}{d_2 - d_1} \quad \surd$$

$$VR = \frac{2 \times 0,3}{0,15 - 0,12} \quad \surd\surd$$

$$= 20 : 1 \quad \surd \qquad (4)$$

2.5 Square threads

2.5.1 Helix angle:

$$Tan\theta = \frac{lead}{\pi D_m} \quad \surd$$

$$= \frac{2 \times 12}{\pi(50-6)} \quad \surd \surd$$

$$= 0,1736 \quad \surd$$

$$\theta = 9,849^0 \quad \surd\surd$$

(6)

2.5.2 Leading angle

$$Leading\ angle = 90^0 - (helix\ angle + clearance\ angle) \quad \surd$$

$$= 90^0 - (9,849^0 + 3^0)$$

$$= 90^0 - 12,849^0$$

$$= 77,15^0 \quad \surd$$

(2)

2.5.3 Trailing angle

$$Trailing\ angle = 90^0 + (helix\ angle - clearance\ angle) \quad \surd$$

$$= 90^0 + (9,849^0 - 3^0)$$

$$= 90^0 + 6,849^0$$

$$= 96,85^0 \quad \surd$$

(2)

2.6 Clutches (Torque)

$$T = \mu WnR \quad \surd$$

$$T = 0,35 \times (2,5 \times 10^3) \times 2\left(\frac{0,28}{2}\right) \quad \surd\surd$$

$$= 245\ Nm \quad \surd$$

(4)

[50]

QUESTION 3: TOOLS AND EQUIPMENT
(Learning Outcome 3: Assessment Standard 2)

3.1 Torsion

Torsion is the twisting action in a member caused by two opposing moments along the longitudinal axis of the member. √√ (2)

3.2 Hook's law

3.2.1 Strain √ is directly proportional to the stress √ its deformation causes provided the limit of proportionality/elasticity is not exceeded √ (3)

3.2.2 Line 0–A √ (1)

3.3 Function of tensile test

It is used to determine the tensile strength of material. √√ (2)

3.4 Tensile test

3.4.1 Destructive √ (1)

3.4.2 Piece of material √ (1)

3.4.3 Axial √ (1)

3.4.4 Elongation √ (1)

3.5 Metal Arc Gas Shielded equipment

- MAGS/MIGS is a semi-automatic welding processor with a continuously fed wire from a spool √
- The wire acts as both electrode and filler when the arc is struck between the workpiece and the air. √
- A gas passing through the nozzle forms a protective shield around the welding area. √
- The arc length is self-adjusting, any variations in the arc length by the welder, produces a change in the burn-off rate of the wire √
- The arc rapidly returns to its original length. √
- The arc length is directly proportional to the voltage. √
- With a decrease in current; this causes a decrease in electrode burn-off rate √
- This restores the original arc length. √ (8)

[20]

QUESTION 4: MATERIALS
(Learning Outcome 3: Assessment Standard 3)

4.1 Stainless steel

- With heat it does not warp
- It is a tough material √
- It does not rust √
- Easy to clean √
- Neat in appearance √
- Wear resistance √

(Any 3 x 1) (3)

4.2 Elements of stainless steel

- Iron √
- Carbon √
- Chrome √ (3)

4.3 Brass

4.3.1 Elements that brass contains:

- Copper √
- Zinc √ (2)

4.3.2 Properties:

- Good resistance against corrosion √
- It is ductile and malleable √
- It can be easily cast √

(Any 1x 1) (1)

4.4 Elements of solder

- Lead √
- Tin √ (2)

4.5 Silver solder / Solder

- It has a higher melting point and a variety of applications √
- Resistance against corrosion √ (2)

4.6 **Plastics**

- Thermoplastic √; each time they are heated they become soft and harden when cooled. Can be heated repeatedly and softened and cooled again. √
- Thermosetting; √ when heated, first time, it softens and hardens when cooled. When heated for the second time it will not soften. √ (4)

4.7 **PVC**

Polyvinyl chloride √ (1)

4.8 **Nylon**

- Needs no lubrications √
- Cost is low √
- Low maintenance √
- Very light in weight √
- Easy to machine √
- It's a tough material √
- Affected by exposure to sunlight √

(Any 2 x 1) (2)
[20]

QUESTION 5: SAFETY, TERMINOLOGY AND JOINING METHODS (Learning Outcome 3: Assessment Standards 1, 4 and 5)

5.1 Welding

- Operator must be instructed on how to use equipment safely. √
- Workplace should be partitioned off effectively. √
- Operator should use protective equipment. √
- Provide and maintain effective ventilation. √
- Ensure proper and adequate fire precautions. √ (5)

5.2 Centre lathe

- Don't leave spanners or keys on rotary parts. √
- Use a brush or wire hook to remove shavings and not your hands. √
- Don't adjust the gearbox of the lathe while it is running. √
- Don't lean on the machine. √
- Don't attempt to stop the machine by placing your hand on the chuck while the machine is slowing down. √

(Any 3 x 1) (3)

5.3 Argon or CO_2 regulator

Oil and grease in the presence of oxygen are flammable. √√ (2)

5.4 Indexing

5.4.1 Rapid indexing √ (1)

5.4.2 Angular indexing √ (1)

5.4.3 Simple indexing √ (1)

5.4.4 Differential indexing √ (1)

5.5 Indexing

Hole circles											
Side 1	*24*	*25*	*28*	*30*	*34*	*37*	*38*	*39*	*41*	*42*	*43*
Side 2	*46*	*47*	*49*	*51*	*53*	*54*	*57*	*58*	*59*	*62*	*66*

Standard change gears										
24 x 2	*28*	*32*	*40*	*44*	*48*	*56*	*64*	*72*	*86*	*100*

5.5.1 Simple indexing

$$Indexing = \frac{40}{N} = \frac{40}{119} \quad \surd$$

$$Actual\ indexing = \frac{40}{A} \quad \surd$$

$$= \frac{40}{120} = \frac{4 \times 2}{12 \times 2} \quad \surd$$

$$= \frac{8}{24}$$

Zero full turns and 8 holes on the 24 - hole circle √√ (5)

5.5.2 Change gears

$$\frac{Dr}{Dn} = \frac{A - N}{A} \times \frac{40}{1} \quad \surd$$

$$\frac{Dr}{Dn} = \frac{120 - 119}{120} \times \frac{40}{1} \quad \surd$$

$$\frac{Dr}{Dn} = \frac{1}{120} \times \frac{40}{1} \quad \surd$$

$$\frac{Dr}{Dn} = \frac{40}{120} = \frac{4}{12} \times \frac{6}{6}$$

$$\frac{Dr}{Dn} = \frac{24}{72} \quad \surd\surd$$ (5)

5.6 Gears

5.6.1

$Addendum = module$ √
$= 2,5\ mm$ √ (2)

5.6.2

$Dedendum = 1,25 \times module$ $or = 1,157 \times module$ √
$= 1,25 \times 2,5\ mm$ $= 1,157 \times 2,5$ √
$= 3,125\ mm$ $= 2,8925\ mm$ √ (3)

5.6.3

$Cutting\ depth = 2,25 \times module$ $or = 2,157 \times module$ √
$= 2,25 \times 2,5\ mm$ $= 2,157 \times 2,5$ √
$= 5,625\ mm$ $= 5,3925\ mm$ √ (3)

5.6.4

$Circular\ pitch = \pi \times module$ √
$= \pi \times 2,5\ mm$ √
$= 7,853\ mm$ √ (3)

5.6.5

$Clearance = 0,25 \times module$ $or = 0,157 \times module$ √
$= 0,25 \times 2,5\ mm$ $= 0,157 \times 2,25$ √
$= 0,625\ mm$ $= 0,3925\ mm$ √ (3)

5.6.6

$$PCD = \frac{Circular\ pitch \times number\ of\ teeth}{\pi}$$ √

$$= \frac{7,853 \times 40}{\pi}$$ √√

$$= 99,987\ mm$$ √

$$PCD = m \times T$$ √
$$= 2,5 \times 40$$ √√
$$= 100\ mm$$ √ (4)

5.7 **Welding defects – Weld spatter:**

5.7.1 **Causes:**

- Current too high. √
- Arc too long. √
- Incorrect electrode √
- Surface contamination (e.g. Rust) √

(Any 3 x 1) (3)

5.7.2 **Prevention:**

- Correct current setting. √
- Correct welding technique. √
- Correct electrode √
- Proper surface preparation. √

(Any 3 x 1) (3)

5.8 **Milling cutters**

5.8.1 Equal-angle cutter √ (1)

5.8.2 Convex cutter √ (1)

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QUESTION 6: MAINTENANCE AND TURBINES
(Learning Outcome 3: Assessment Standards 7 and 9)

6.1 Friction bearing failure

- Operating temperature too excessive. √
- Oil supply has foreign materials and /or contaminated with water. √
- Bearing material is corroded. √
- Incorrect lubricant used. √
- Lubrication insufficient. √
- Faulty design. √
- Poor maintenance and incorrect assembly. √

(Any 4 x 1) (4)

6.2 Cutting fluid

- Carry away the heat generated by machining process √
- Acts as a lubricant √
- Prevents the chips from sticking and fusing to the cutter teeth √
- Improves quality of the finish of the surface √
- To keep the workpiece and the cutting tool cool √
- To obtain a high cutting speed √
- It gives a cutting tool a longer lifespan √

(Any 4 x 1) (4)

6.3 Properties of oil

6.3.1 **Viscosity of oil**:

Refers to the resistance √ of oil to flow. √ (2)

6.3.2 **Pour point:**

Refers to the lowest temperature √ at which a liquid can flow. √ (2)

6.4 Belt slip

- Overloading the belt. √
- Lubricants on the contact surface. √
- Belt too slack. √
- Worn belt. √
- Contact angle on pulley too small. √

(Any 4 x 1) (4)

6.5 **Lubricating oil**

6.5.1 SAE = Society of Automotive Engineers. √ (1)

6.5.2 20 = Oil thin enough to be used in winter. √ (1)

6.5.3 W = Winter. √ (1)

6.5.4 50 = Oil thick enough to be used in summer. √ (1)

6.6 **V-belts**

6.6.1 **Advantages**

- V-belts are used over short distances. √
- It is silent in operation. √
- Requires very little maintenance. √
- Is able to absorb shock loads √
- Operate a low bearing pressure. √
- In a multi-V-belt drive, if one belt breaks the machine can still run on the remaining belts. √

(Any 3 x 1) (3)

6.6.2 **Disadvantages**

- Cannot repair a broken V-belt √
- Unsuitable for long distances √
- V-belts have the tendency to pull tighter under heavy loads, and cause further damage when machine seizes √
- V-belts cannot be used on fixed and loose pulleys √

(Any 3 x 1) (3)

6.7 **Blower**

6.7.1 **Type of blower**

Vane-type blower √√ (2)

6.7.2 **Parts**

1. Inlet √
2. Outlet √
3. Rotor √
4. Vane √ (4)

6.8 **Steam turbine – advantages**

- It is compact. √
- No lubrication is required. √
- Steam turbine speeds can be more accurately regulated. √
- A variety of fuels can be used to obtain steam. √
- Steam turbines are more economical. √
- Higher speeds can be obtained as compared to internal combustion engine. √

(Any 4 x 1) (4)

6.9 **Gas turbine – advantages**

- High power output from a given weight of engine. √
- The torque output characteristic permits a notable simplification of the transmission system. √
- Smooth vibration less running due to absence of reciprocating parts. √
- No rubbing parts such as piston so that internal friction and wear are almost eliminated. √
- Easy starting. √
- Can use wide range of fuels and does not require expensive anti-knock additives. √
- Low lubricating-oil consumption. √
- No water-cooling system needed. √
- Non-poisonous exhaust giving very little trouble with pollution. √
- Requires little routine maintenance √

(Any 4 x 1) (4)

[40]

TOTAL: 200