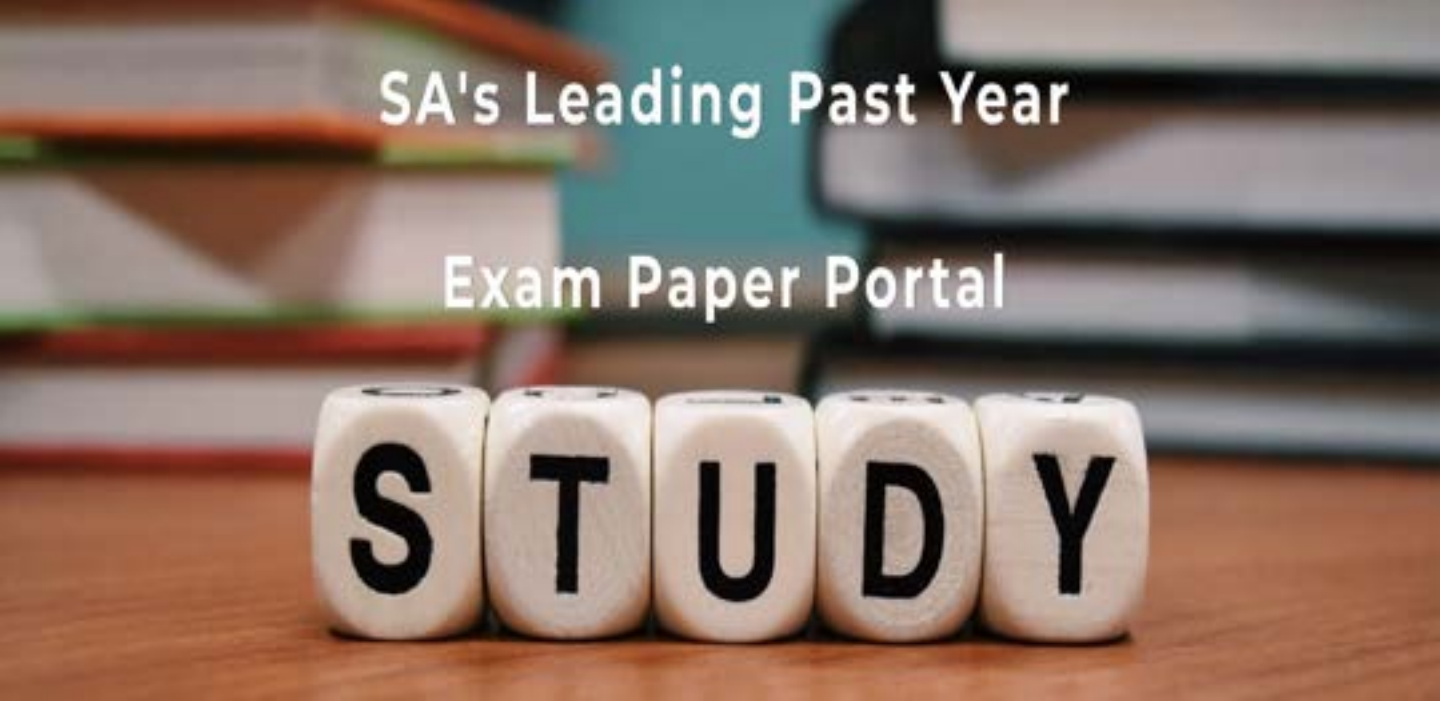

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GRADE 12

MECHANICAL TECHNOLOGY

FEBRUARY/MARCH 2011

MEMORANDUM

MARKS: 200

This memorandum consists of 15 pages.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

(Learning Outcome 3: Assessment Standard 1 – 9)

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

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QUESTION 2: FORCES AND SYSTEMS AND CONTROL

(Learning Outcome 3: Assessment Standard 6 and 8

2.1 Stress and strain

2.1.1 Compression Stress √ (1)

2.1.2 Stress in material

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

$$= \frac{\pi(0{,}04^2 - 0{,}03^2)}{4}$$

$$= 0{,}55 \times 10^{-3}\ m^2 \quad \surd$$

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

$$= \frac{23 \times 10^3}{0{,}55 \times 10^3} \quad \surd$$

$$= 41{,}84\ MPa \quad \surd\ (5)$$

2.1.3 Shortening of bush

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

$$= \frac{41{,}82 \times 10^6}{90 \times 10^9} \quad \surd$$

$$= 0{,}46 \times 10^{-3}$$

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

$$= 80 \times (0{,}46 \times 10^{-3}) \quad \surd$$

$$= 36{,}8 \times 10^{-3}\ mm \quad \surd\ (5)$$

2.2 **Hydraulic**

2.2.1 Fluid pressure

$$A_p = \frac{\pi D^2{}_p}{4}$$
$$= \frac{\pi \times 0{,}038^2}{4} \quad \surd$$
$$= 1{,}13 \times 10^{-3}\ m^2$$

$$p = \frac{F_p}{A_p} \quad \surd$$
$$= \frac{200}{1.13 \times 10^{-3}}$$
$$= 0{,}18\ MPa \text{ or } 176348{,}9674\ Pa \quad \surd \quad (3)$$

2.2.2 Diameter of ram

$$A_r = \frac{F_r}{p} \quad \surd$$
$$= \frac{23 \times 10^3}{0{,}18 \times 10^6} \quad \surd$$
$$= 0{,}13\ m^2$$

$$A = \frac{\pi D^2}{4} \quad \surd$$
$$\sqrt{D^2} = \sqrt{\frac{4A}{\pi}}$$
$$D = \sqrt{\frac{4(0{,}13)}{\pi}}$$
$$= 0{,}41 m \text{ or } 0{,}4075\ m$$
$$= 410 mm \text{ or } 407{,}5\ mm \quad \surd \quad (4)$$

2.3 Gear Drive

2.3.1 Rotation of motor

$$N_E = \frac{80 \times 40 \times 90}{30 \times 20}$$

$$= \frac{288000}{600} \quad \surd$$

$$= 480 \text{ r/min} \quad \surd \quad (2)$$

2.3.2 Advantages \

- No slip occurs √
- It is much stronger √
- More accurate √
- Last longer (Any TWO correct answers) √ (2)

2.4 Belt Drive

2.4.1 Diameter of driven pulley

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

$$= \frac{710 \times 420}{220} \quad \surd$$

$$= 1355,5\ mm \quad \surd \quad (3)$$

2.4.2 Width of belt

$$\frac{T_1}{T_2} = 2,5$$

$$\therefore T_1 = 2,5T_2 \quad \surd$$

$$Power = \frac{(T_1 - T_2)\pi Dn}{60}$$

$$8 \times 10^3 = \frac{(2,5T_2 - T_2) \times 0,42 \times 710}{60} \quad \surd$$

$$\therefore T_2 = 341,6\ N \quad \surd$$

$$T_1 = 2,5T_2$$

$$= 2,5 \times 341,6$$

$$= 854\ N \quad \surd$$

$$Tensile\ force\ is\ 4\ N\ per\ mm\ belt\ width.$$

$$\therefore Width = \frac{854}{4} \quad \surd$$

$$= 213,5mm \quad \surd \quad (6)$$

2.5 Gear Teeth

2.5.1 Pitch circle diameter = Module x Number of teeth
= 4 x 60 √
= 240 mm √ (2)

2.5.2 Addendum = Module √
= 4 mm √ (2)

2.5.3 Clearance = 0,25 x module or 0,157 x module
= 0,25 x 4 or 0,157 x 4 √
= 1 mm or 0,628 mm √ (2)

2.5.4 Dedendum = 1,25 x module or 0,157 x module
= 1,25 x 4 or 1,157 x 4 √
= 5 mm or 4,628 mm √ (2)

2.5.5 Outside diameter = PCD + 2 module
= 240 + 2(4) √
= 248 mm √ (2)

2.6 Square thread cutting tool

A = Trailing/Following angle, **B** = Leading angle √√
C =Clearance angle, **D** = Helix angle √√ (4)

2.7 Clutches

2.7 Friction clutch

$$T = \mu WnR$$

$$R = \frac{T}{\mu Wn} \quad \surd$$

$$R = \frac{245}{0,35 \times 2500 \times 2} \quad \surd$$

$$R = \frac{245}{1750}$$

$$R = 0,14\,m \quad \surd$$

$$D = 2R$$

$$D = 2(0,14) \quad \surd$$

$$D = 0,28\,m$$

$$D = 280\,mm \quad \surd \text{ (5)}$$

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QUESTION 3: TOOLS AND EQUIPMENT

(Learning Outcome 3: Assessment Standard 2)

3.1 **Brinell hardness tester**

1. Test piece √
2. Load √
3. Hardened steel ball √
4. Diameter of impression √ (4)

3.2 **Tensile test**

To determine, √
the yield stress, √
the ultimate tensile stress, √
the percentage elongation of a piece of material. √ (4)

3.3 **Wet compression test**

- To determine worn rings √
- To determine worn piston √
- To check if there is a difference in readings between the dry test and the wet test √
- To verify if there is a need for performing the cylinder leakage test √ (4)

3.4.1 Gas analyzer √√ (2)

3.4.2 Carbon Monoxide (CO) and Carbon Dioxide (CO_2) and water (H_2O) √√ (2)

3.5 **Torsion**

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

3.6 Is to investigate the deflection of the beam to see if the beam will withstand the required force (Testing for rigidity) √√ (2)

[20]

QUESTION 4: MATERIALS

(Learning outcome 3: Assessment standard 3)

4.1 Tin snips

4.1.1 High carbon steel or Tool steel √ (1)

4.1.2
- They resist wear √
- It has high tensile strength √ (2)

4.1.3
- To prevent rust √ (1)

4.2 Ferrous alloys

They are alloys that contain iron √

examples
- Low, medium and high carbon steels,
- stainless steel,
- chromium steel
- manganese steel
- vanadium steel
- titanium √
- tungsten steel √ (Any TWO correct answers) (3)

4.3 Hammer head

4.3.1 Medium carbon steel √ (1)

4.3.2
- Very tough √
- High tensile strength √ (2)

4.4 Tensile definition

The ability of a material to withstand pulling forces or tension forces √√ (2)

4.5 Tensile strength

Material B has the lowest tensile strength because it **deforms easily** √ under tension or is the most deformed material. √ (2)

4.6 **Electric plug**

4.6.1 Nylon √
- It has resistance to wear √
- It is a good insulator √
- It has low frictional properties. (Any TWO correct answers) (2)

4.6.2 Bronze √
- Strong √
- Tough √
- Corrosion resistance √
- Good conductor of electricity (Any TWO correct answers) (2)

4.7 **Properties of Carbon Fibre**
- Stiff and strong √
- Low density √
- Light weight √
- Resistant to corrosion (Any TWO: 1 x 2) √ (2)

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QUESTION 5: SAFETY, TERMINOLOGY AND JOINING METHODS

5.1 **Torsion tester**

- Use safety goggles √
- Make sure the workpiece is properly tightened. √
- Be careful for metal particles coming off after the metal fractures. √
- Do not hold the test piece with your hands; it may be hot, use pliers. √ (4)

5.2 **MIG welder**

- The welding area must be kept clean and tidy. √
- Operator must use protective equipment √
- Make sure that the main cable insulation is not damaged when welding. √
- Gas bottle must be well secured with a chain √
- Welding area must have effective ventilation √
- Welding must not be carried out in areas of explosive and flammable liquids. √
- Use a fume extractor for toxic fumes given off when welding galvanized or zinc coated material √ (4)

(Any FOUR correct answers)

5.3 **Helical cutter**

- Uses less power √
- Vibration experience by machine is less √
- Longer life span for the cutter √
- Deeper cuts may be taken √
- Wider cutters may be used √ (4)

(Any FOUR correct answers)

5.4 **Dividing head**

To divide the circumference of a circular work into equally spaced dimension. √√ (2)

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 Indexing

$$Indexing = \frac{40}{n} = \frac{40}{160} \quad \surd$$

$$= \frac{1}{4} \times \frac{7}{7} or \frac{1}{4} \times \frac{6}{6} \quad \surd$$

$$= \frac{7}{28} \ or \frac{6}{24} \quad \surd$$

7 holes on a 28-hole circle or 6 holes on a 24-hole circle √√ (5)

5.5.2 Change gears

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

$$= (160 - 163) \times \frac{40}{160} \quad \surd$$

$$= \frac{-3 \times 40}{160} \quad \surd$$

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

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

$$= \frac{-24}{32} \quad \surd$$

Drive gear is 24 and the driven gear is 32 √ (5)

5.5.3 The index plate rotates in the opposite direction to the crank handle (-) √√ (2)

5.6 **Cutting speed**

$V = \pi DN$ √

$N = \frac{V}{\pi D}$ √

$N = \frac{200}{\pi \times 0,2}$ √

$N = 318.31 rpm$

√

$f = f \times T \times N$ √

$f = 0,1 \times 20 \times 318.31$ √

$f = 636.62 mm/min$ (6)

5.7 **Dividing head**

1. Plunger √
2. Index plate √
3. 40-teeth worm wheel √
4. Single start worm √
5. Sector arm √ (5)

5.8 **Liquid/dye penetrate test**

- Clean the surface to be tested. √
- A liquid dye penetrant is sprayed onto the clean surface. √
- Allow a short time for the dye to penetrate the welded joint. √
- Remove the excess dye on the welded joint using a cloth. √
- Wash the surface and allow it to dry thoroughly. √
- Spray a developer on the surface which brings out the color in the dye penetrant, that has penetrated the cracks or pin holes. √
- Should the liquid dye come out of the welded joint, it means there are flaws in the joint. √ (7)

5.9 **Incomplete penetration**

Causes:

- Current too low √
- Electrode too large √
- Joint preparation incorrect √
- Weld speed too fast (Any THREE correct answers) √ (3)

Cures/Prevention

- Use correct current √
- Proper electrode should be used √
- Joint should prepared properly √
- Correct speed should be used (Any THREE correct answers) √ (3)

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QUESTION 6: MAINTENANCE AND TURBINES

(Learning Outcome 3: Assessment Standard 7 and 9)

6.1 Lubricating oil

6.1.1 Label – timing chain

1. Timing chain √
2. Camshaft pulley √
3. Chain guide √
4. Crankshaft pulley √
5. Tensioner √ (5)

6.1.2 Needs of lubricating oil

- Viscosity must be correct. √
- It must resist oxidation. √
- It must prevent rust. √
- It must avoid foaming. √
- Resist carbon forming. √
- It must prevent corrosion. √
- It must resist extreme pressures (Any FOUR correct answers) √ (4)

6.1.3 Reasons for oil change

- Formation if gum, acids and lacquer may be left by the combustion of the fuel. √ √
- Loses its viscosity after a while due to heat.
- Metal particles due to metal and metal contact √ (3)

6.2 Oils

6.2.1 SE - The letter 'S' Spark Ignition Engines √ (1)

6.2.2 CE - The letter 'C' Compression Ignition Engine √ (1)

6.2.3 SAE 20W50 - Society of Automotive Engineers. Multi grade oil √√ (2)

6.2.4 ATF - Automatic transmission fluid √ (1)

6.3 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. √
- Improve quality of the finish of machined surface. √
- To obtain a higher cutting speed. √
- It gives the cutting tool a longer lifespan. √
- Does not rust the machine. (Any FOUR correct answers) √ (4)

6.4 **Properties of grease**

- It must be water resistant, it must not mix √
- Rust/corrosion resistant √
- Good for load pressure √
- High melting point √
- Low freezing point (Any THREE correct answers) √ (3)

6.5 **Superchargers**

6.5.1 Purpose:

- The supercharger fills the cylinder with an increased pressure that is higher than atmospheric pressure. √
- The compression pressure in the cylinder is increased. √
- The volumetric efficiency of the engine is increased. √

(Any TWO correct answers) (2)

6.5.2 Examples:

- Used in racing cars. √
- Four-stroke Compression Ignition engines in heavy vehicles. √
- Earth moving equipment √
- Aircraft engine to overcome loss of power owing to height above sea level. (Any THREE correct answers) √ (3)

6.5.3 Advantages:

- More power is obtained compared to a similar vehicle without supercharger. √
- Supercharged engines are more economical per given kilowatt output. √
- Less fuel is used compared to engine mass. √
- Power loss is eliminated above sea level √ (3)

(Any THREE correct answers)

6.6 **Turbocharger**

- A turbocharger is driven by the exhaust gasses of the engine and therefore there is no power loss. √√
- The turbocharger is generally cheaper. (Any ONE correct answer) √√ (2)

6.7 **Steam turbines**

- It is compact √
- No lubrication is required √
- Steam turbine speed can be more accurately regulated √
- A variety of fuels can be used to obtain steam √
- More economical (Any THREE correct answers) √ (3)

6.8 **Gas turbines**

- Easy starting √
- High power output from the given weight of engine √
- No rubbing parts such piston so that internal friction and wear are almost eliminated. √
- No water cooling system needed √
- Requires little routine maintenance (Any THREE correct answers) √ (3)

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TOTAL: 200