MEMORANDUM

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MECHANICAL TECHNOLOGY

This memorandum consists of 14 pages.

QUESTION 1: MULTIPLE CHOICE QUESTIONS

(Learning Outcome 3: Assessment Standards 1 – 6)

1.1	D	(1)
1.2	A	(1)
1.3	B	(1)
1.4	A	(1)
1.5	A	(1)
1.6	C	(1)
1.7	B	(1)
1.8	C	(1)
1.9	D	(1)
1.10	B	(1)
1.11	D	(1)
1.12	D	(1)
1.13	A	(1)
1.14	D	(1)
1.15	A	(1)
1.16	D	(1)
1.17	B	(1)
1.18	A	(1)
1.19	B	(1)
1.20	C	(1)
		(20)

QUESTION 2

2.1.1 Solution for reaction forces.
Taking moments about Q
Clockwise moments = Anti-clockwise moments.

P x 15 = (650 x 2) + (400 x 8) + (500 x 12) ✓
P x 15 = 1300 + 3200 + 6000 ✓
P x 15 = 10 500

$$P = \frac{10\ 500}{15}$$

P = 700 N [5]

2.1.2 Taking moments about P
Anticlockwise moments = Clockwise moments

Q x 15 = (500 x 3) + (400 x 7) + (650 x 13) ✓
Q x 15 = 1500 + 2 800 + 8 450 ✓

Q x 15 = 12750 ✓

$$Q \times 15 = \frac{12750}{15}$$ ✓

Q = 850 N ✓ [5]

2.1.3 and 2.1.4

2.2 Definitions of properties

2.2.1 Stress: May be defined as the internal resistance in a body, to an external force or load. It is directly proportional to the applied load and inversely proportional to the cross-sectional area of the body. (2)

2.2.2 Strain: Is the ratio between the change in length and the original length and is expressed as a constant. (2)

2.2.3 Tensile stress: Is an internal force present in material when an external tensile load is applied. (2)

2.2.4 Shearing stress: An internal force in material which resists a shearing load or force between two shearing planes. (2)

2.2.5 Safety sector : Is the number of times with which the maximum stress is decreased to obtain a safe stress. (2)

2.3 Calculate strees:

Area = $\frac{\pi d^2}{4}$

Area = $\frac{\pi 15^2}{4}$

Stress = $\frac{\text{Load}}{\text{Cross-sectional area}}$

Stress = $\frac{30 \times 10^3}{\frac{\pi 15^2}{4 \times 10^6}}$

Stress $\frac{30 \times 10^3 \times 4 \times 10^6}{\pi\ 15^2}$

Stress = $\frac{120 \times 10^9}{\pi\ 225}$ ✓

Stress = 169,77 MPa ✓ (4)

2.4 Calculate the strain

Strain = $\frac{\text{chance in length (x)}}{\text{Original length (1)}}$

Strain = ?

X = 0,5

Strain = $\frac{0{,}5 \text{ mm}}{6\ 000 \text{ mm}}$ ✓✓

Strain = 0,000083 or $8{,}3 \times 10^{-5}$ (5)

2.5 Calculate Young's modulus of Elasticity (E) = $\frac{\text{Stress}}{\text{Strain}}$

Step 1 **Calculate stress**

Stress = $\frac{\text{Load}}{\text{Cross Sectional area}}$

Load = 100 kN.

Cross sectional area = $\frac{\prod 32^2}{4}$ ✓

Stress = $\frac{100 \times 10^3}{\frac{\prod 32^2}{4 \times 10^6}}$ ✓

Stress = $\frac{100 \times 10^3 \times 4 \times 10^6}{\prod 32^2}$

Stress = $\frac{400 \times 10^9}{\prod \times 1024}$ (5)

Stress = 124,34 MPa

Step 2 **Calculate strain**

Strain = $\frac{\text{change in length (x)}}{\text{Original length (1)}}$

Strain = $\frac{0,5 \text{ mm}}{120 \text{ mm}}$ ✓

Strain = 0,00416 ✓ (2)

Step 3 **Calculate Young's modulus**

Young's modulus (E) = $\frac{\text{Stress}}{\text{Strain}}$

E = $\frac{124,34 \times 10^6}{0,00416}$ ✓✓

E = 29,88 GPa ✓ (3)

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QUESTION 3

3.1 OPERATION OF THE GAS ANALYSER

- Connect the analyzer to 12 volt vehicle battery terminal and allow the vehicle to reach normal temperature
- The LED will display '000' for the first 30 seconds until 0.00 is displayed.
- Increase the rev counter reading 2500 r/min
- Do not connect armoured hose from condenser pickup to the rear of machine until 0.00 is displayed (Calibration is completed)
- Insert the silicon hose probe to the rear end of exhaust pipe
- Unroll the armoured hose and connect to the rear of the analyser
- Observe the reading. If not within specification, carry out adjustment (6)

3.2 CYLINDER LEAKAGE TEST RESULTS

- Listen at the carburetor for wind noise. (Inlet valve leaking)
- If there is a noise at the exhaust tail pipe. (Exhaust valve leaks)
- Pull the dipstick out if there is a noise. (Piston rings are worn)
- Remove the oil filler cap if there is a noise. (Rings are worn)
- Open the radiator cap to see if the water is bubbling. (Blown cylinder head gasket).
- If there are bubbles in the radiator water. (Cylinder block is cracked.) (6)

3.3 A MECHANICAL TUBE BENDER (LABELS)

1. Lever
2. Adjusting screw
3. Lock nut
4. Roller
5. Stop
6. Inner former
7. Tube
8. Guide (8)

[20]

QUESTION 4

4.1 PROPERTIES OF STEEL

4.1.1	Toughness	:	Ability of metal to withstand shock loads.
4.1.2	Elasticity	:	Ability of metal to return to its original shape after the load has been removed.
4.1.3	Malleability	:	It is the ability of metal to be hammered or rolled without breaking or cracking.
4.1.4	Ductility	:	It is the ability of metal to stretch and become permanently deformed without breaking or cracking.
4.1.5	Brittleness	:	It is tendency of a metal to fail suddenly by breaking without any permanent deformation of the metal before failure.
4.1.6	Hardness	:	It is the ability of a metal to resist penetration or piercing after forging.
4.1.7	Tensile strength:		This is the resistance of a metal to a force which is acting to pull it apart.

(7 x 2) (14)

4.2 THE PURPOSE OF THE FOLLOWING HEAT TREATMENT

4.2.1	Annealing	:	Softening the metal.
4.2.2	Normalising	:	Refining the structure after it has been distorted by hammering.
4.2.3	Hardening	:	Enables the metal to resist wear or cut other metals

(2 x 3) (6)

[20]

QUESTION 5

WELDING SAFETY

5.1 Accept any FOUR of the following:

1 An operator has been instructed how to use the machine safely.
2 A workplace is effectively partitioned off.
3 Use protective equipment
4 Effective ventilation
5 The use of safe air breathing masks and hoods
6 The use of personal protective clothing
7 The insulation of electrical leads is satisfactory. (Only four) (4)

5.2 SURFACE GRINDER:

1. Protective clothes and eye protection are essential when working with a surface grinder.
2. Before operating the surface grinder, be sure you have been properly taught how to control it and you know about the potential dangers associated with it.
3. Do not operate the surface grinder unless all guards and safety devices are in place and working correctly.
4. Understand the operating instructions applicable to your machine.
5. Never clean or adjust the machine whilst it is in motion.
6. Immediately report any dangerous aspect of the machine and stop using it until it has been repaired by a qualified person.
7. You may have to stop your machine in an emergency.
8. Learn how to do it without having to stop and think about it. (any 4) (4)

5.3 GUILLOTINE SAFETY

5.3.1 A fixed guard to prevent hands or fingers reaching through, over, under or around the guard
5.3.2 A self–adjusting guard which automatically adjust to the thickness of the material being worked.
5.3.3 Automatic sweep – away or push – away device
5.3.4 Electronic presence – sensing device which stop the machine when sensing any foreign object in the danger zone. (any 2) (2)

5.4 HYDRAULIC PRESS:

- The predetermined pressure must never be exceeded. This operating pressure is always less than the maximum safe pressure and is shown by a pressure gauge on the apparatus.
- Pressure gauges must be tested regularly and adjusted or be replaced if any malfunction occurs.
- The platform on which the work piece rests must be rigid and square with the cylinder of the press.
- The platform must rest on the supports provided and should not be supported by the cable by which it is raised or lowered.
- Objects to be pressed must be placed in suitable jigs.
- Ensure that the direction of pressure is always at 90° to the platform.
- To prevent damage to soft material, the prescribed equipment must be applied. (any 5) (5)

5.5 ACETYLENE GAS

1 Cylinder must be kept away from heat
2 Separate oxygen and combustible gases
3 Oil and grease should be kept away from the cylinder joints and fittings
4 Leakages must be tested with soapy water only
5 Acetylene in contact with copper or silver form explosive compound
6 Cylinders should not be used as jacks, rollers or support (any 5) (5)

5.6 CUTTING - OFF STOCK (POWER SAW)

1 Set the vice a right angle to the blade if a square cut is required
2 Adjust the blade guides so that they are only slightly wider than the stock to be cut
3 Set the cutting pressure and turn on the cutting fluid.
4 Turn off the power and check that the cutting operation is faultless.
5 When the cut is complete, the machine will stop automatically.
Switch off the cutting supply. (5)

5.7 DRILL BITS TIPS

A Tip-angle 118 degrees normal point for easily drilled material (2)
B Tip-angle 135 degree flat point for difficult to drill material (2)
C Tip-angle 90 degrees long point for abrasive material (2)

5.8 INDEXING

- Simple indexing
- Rapid indexing
- Angular indexing
- Differential indexing (1 x 4) (4)

5.9 MILLING MACHINE (LABELLING)

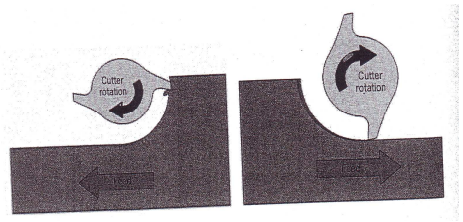
1 Base
2 Hand wheel
3 Knee and saddle
4 Machine table
5 Arbor support
6 Adjustable over arm
7 Horizontal spindle
8 Power feed unit (8)

5.10 MILLING PROCESSES

A Milling – down process the cutter and feed rotates in the same direction this motion of the feed tends to pull the work piece into the cutter (2)

B Milling – up process the cutter turns against the direction of feed as the work piece moves towards it. (2)

Drawing:



(2)

5.11 The dividing head is a device for dividing the circumference of the work piece Into a number of equal parts. (1)

1. Worm and worm-wheel
2. Index crank
3. Index plate
4. Sector arm (4)

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QUESTION 6:

6.1 WELDING DEFECTS

6.1.1 POOR PENETRATION

Causes

(Any two)

- ❖ Using wrong electrode
- ❖ Speed too fast
- ❖ Current too low
- ❖ Faulty preparation

Cure/Remedy

(Any one)

- ❖ Use proper electrode
- ❖ Select an electrode according to welding groove size.
- ❖ Leave enough free space at the bottom of the weld.
- ❖ Use enough current to obtain the desired penetration and weld slowly.

(any 3) (3)

6.1.2 Poor fusion

Causes

(Any two)

- ❖ Wrong speed
- ❖ Current improperly adjusted
- ❖ Faulty preparation
- ❖ Improper electrode size

Cure/Remedy

(Any one)

- ❖ Adjust electrode and V-sizes
- ❖ Weave must be sufficient to melt sides of joint
- ❖ Proper current will allow deposition and penetration
- ❖ Prevent weld metal from curling away from plates. (any 3) (3)

6.1.3 Spatter

Causes

(Any two)

- ❖ Arc blow
- ❖ Current too high
- ❖ Arc too long
- ❖ Faulty electrodes (any 3) (3)

6.1.4 Cracks

Causes

(Any two)

- ❖ Wrong electrode
- ❖ Weld sizes do not match
- ❖ Faulty welds
- ❖ Faulty preparation
- ❖ Rigid preparation (any 3) (3)

Cure

(Any one)

A well — designed structure and welding procedures eliminate rigid joints
Heat the parts before welding
Avoid welds in string beads
Keep the ends free to move as long as possible
Make sound welds with good fusion
Adjust the weld size to the parts size
Allow joints a proper and uniform free space
Work with amperage as low as possible

(4 x 3) (12)

6.2.1

- Colour dye penetrant
- X-ray
- Ultrasonic test
- Magnetic test (any 3) (3)

6.2.2 COLOUR DYE PENETRANT

Procedures
A colour dye penetrant liquid is used to inspect for cracks on the surface

Method:

The coloured dye penetrant liquid is sprayed on the clean section of the workpiece to be tested, and allowed to penetrate into the metal. The excessive liquid is wiped off with water and allowed to dry.

Development liquid is sprayed onto the surface as soon as the surface is dry. The development liquid brings the colour dye penetrant that is trapped in the cracks to the fore. (7)

OR

X-ray

Procedures

Welded joints can be inspected for internal defects by means of X-rays.
X-rays is a wave of energy that can be send through most materials so that the image can be filmed permanently.
Defects like cracks, weak penetration, slag — inclusion and porosity can easily be traced though X-rays
The depth of a defect in steel cannot be detected from one side.
X-rays must for this reason be taken from both sides of the weldjoint. (7)

OR

ULTRASONIC TEST

Procedures

High frequently sound waves is send into the metal at very short intervals (1 – 3 micro seconds) and then stopped.
After this the same unit used to send unit used to send the waves, is used as receiver to listen to the ultrasonic waves that is reflected by the metal.
The waveflow breaks and the reflected waves is intercepted by the combined receiver unit.
The cycle is repeated between half million and one million times per second.
Every wave is shown on a oscilloscope.
This oscilloscope is calibrated to detect only defects that is detrimental to the weldjoint.
The oscilloscope's wave pattern is also calibrated to show any type of defect. (7)

OR

MAGNETIC TEST

Procedures

This method can be used successfully to determine the presence of internal and surface defects for applications such as welds.
Magnetisation of the work is accomplished by passing electric current through it or by the influence of an external magnetic yoke.
Small local poles are thus produced at the extreme edge of the defects.
These can be indicated by the allocation preserved by covering the surface with a finely divided paramagnetic substance such as iron dust.
This can be applied dry or flowed on as a suspension in oil, water or any suitable vehicle. (7)

6.3 The mains fusion welding processed are;

- ❖ Oxy-yacetylene welding (OAW)
- ❖ Shield metal arc welding (SMAW)
- ❖ Gas tungsten arc welding (GTAW)
- ❖ Gas metal arc welding (GMAW)
- ❖ Submerged — arc welding
- ❖ Electron bema (not dealt with in this module) (2 x 5) (10)

6.4 Safety precaution on welding: (Name only two from each)

6.4.1 Electric Shock

- ❖ Hand gloves must be worn
- ❖ Electric holder must be efficiently insulated
- ❖ Hazard electricity regulations must be observed
- ❖ Connection cables must be well insulated (any 2) (2)

6.4.2 Fumes Shock

- ❖ Respirators must be worn
- ❖ Enough ventilation to avoid inhailing
- ❖ Suction fans must be installed inside booth in the case of welding in a confined space (any 2) (2)

6.4.3 Arc Rays

- ❖ A standard coloured lens filled in a shield must be used to avoid radiation
- ❖ Safety glasses fitted with standard coloured lenses should be worn
- ❖ The face shield or masks must cover both the face and the neck. (any 2) (2)

6.4.4 Sparks

- ❖ An overall must be worn
- ❖ In the case of an overhead welding, an apron, gauntles, and a helmet with the correct lense fitted must be worn.
- ❖ Leather gloves and safety shoes must be worn.
- ❖ Leather spats must be worn (any 2) (4 x 2) (8)

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GRAND TOTAL: 200