NATIONAL SENIOR CERTIFICATE EXAMINATION
NOVEMBER 2021

MECHANICAL TECHNOLOGY: WELDING AND METALWORK

MARKING GUIDELINES

Time: 3 hours 200 marks

These marking guidelines are prepared for use by examiners and sub-examiners, all of whom are required to attend a standardisation meeting to ensure that the guidelines are consistently interpreted and applied in the marking of candidates' scripts.

The IEB will not enter into any discussions or correspondence about any marking guidelines. It is acknowledged that there may be different views about some matters of emphasis or detail in the guidelines. It is also recognised that, without the benefit of attendance at a standardisation meeting, there may be different interpretations of the application of the marking guidelines.

QUESTION 1 MULTIPLE CHOICE (Generic)

1.1 C

1.2 C

1.3 B

1.4 A

1.5 A

1.6 B

QUESTION 2 SAFETY (Generic)

2.1 A full first-aid kit must be provided where five or more workers are present. Workers must be informed where the kit is situated / placed, and the signs must be put up.

2.2
- To protect your eyes from the spatter/sparks.
- To protect your eyes from the harmful rays/UV rays.
- To ensure proper vision of the process.

(Any 2 × 1)

2.3
- Overall
- Safety goggles/face shield
- Safety shoes
- Safety gloves

(Any 2 × 1)

2.4
- Ensure that the work area is well ventilated, and the welder can always inhale clean, fresh air.
- When zinc, galvanised material is be welded, suction fan systems should be used.
- Avoid welding directly in the gas cloud produced from welding.
- When welding in small spaces, welding suction fan systems should be used.

(Any 2 × 1)

2.5
- To prevent HIV/AIDS or any blood-related infections being transmitted.
- To prevent contamination of the open wounds.

QUESTION 3 MATERIALS (Generic)

3.1 Heat treatment is the controlled heating and cooling of carbon steel in its solid form to change its properties.

3.2 It is a surface-processing process to create a hard shell over a soft core.

3.3 3.3.1 Oil for rapid

3.3.2 Brine for extreme

3.4 Oil

3.5 Relieve internal stresses produced by machining, forging and welding.

QUESTION 4 MULTIPLE CHOICE (Specific)

4.1 B

4.2 D

4.3 B

4.4 B

4.5 D

4.6 C

4.7 A

4.8 B

4.9 B

4.10 D

4.11 C

4.12 D

4.13 C

4.14 C

QUESTION 5 TERMINOLOGY (Templates) (Specific)

5.1 To indicate the additional/supplementary information regarding the weld.

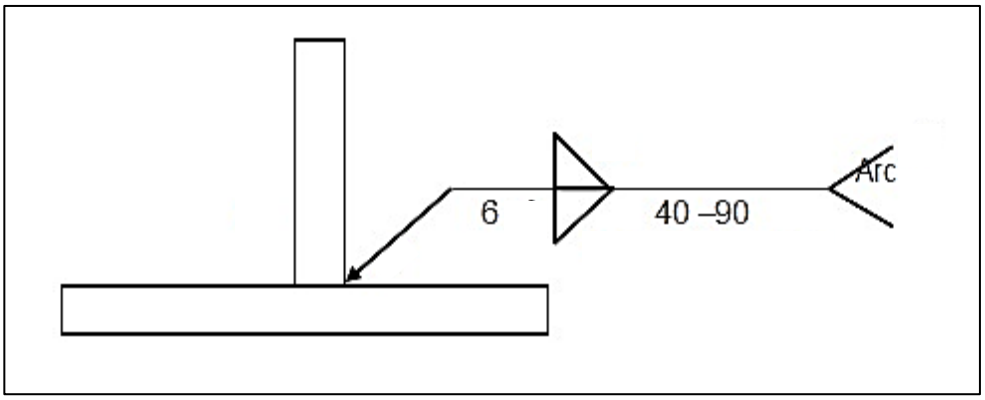
5.2 Mean diameter = ID + Plate thickness
Mean diameter = 550 + 8
Mean diameter = 558 mm

Circumference = π × *Mean diameter*
Circumference = π × 558
Circumference = 1 753 mm or 1 754 mm

5.3
- Spot welding
- Projection
- Seam welding
- Foil seam welding
- Flash or resistance butt
- Gas welding
- MIG/MAGS Welding
- Arc welding

(Any 4 × 1)

5.4



5.5 5.5.1 G Grind

5.5.2 F Flame

5.5.3 M Machine

5.5.4 Convex

QUESTION 6 TOOLS AND EQUIPMENT (Specific)

6.1 6.1.1 The blade is tensioned in the frame and cuts in a forward stroke, and the blade is lifted in the backward (reciprocating) motion.
The blade assembly is raised and lowered by hydraulicconstrols to ensure that the cutting pressure is optimum.

6.1.2 This guillotine is operated by a foot/hand pedal/lever that activates a pressure plate/blade guard.
The blade cuts the material.
The cut material is ejected at the back of the machine.
Extension bars lengthen the work surface and support longer pieces of material.

6.2 The cylinder is filled with a porous mixture of aluminium silicate and charcoal particles. This absorbs acetone twice the volume of acetylene.

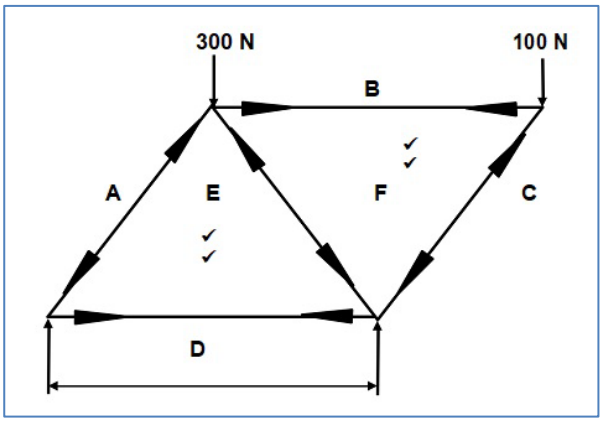
6.3
- Mild steel
- Alloy steels
- Stainless steels
- Non-ferrous metals

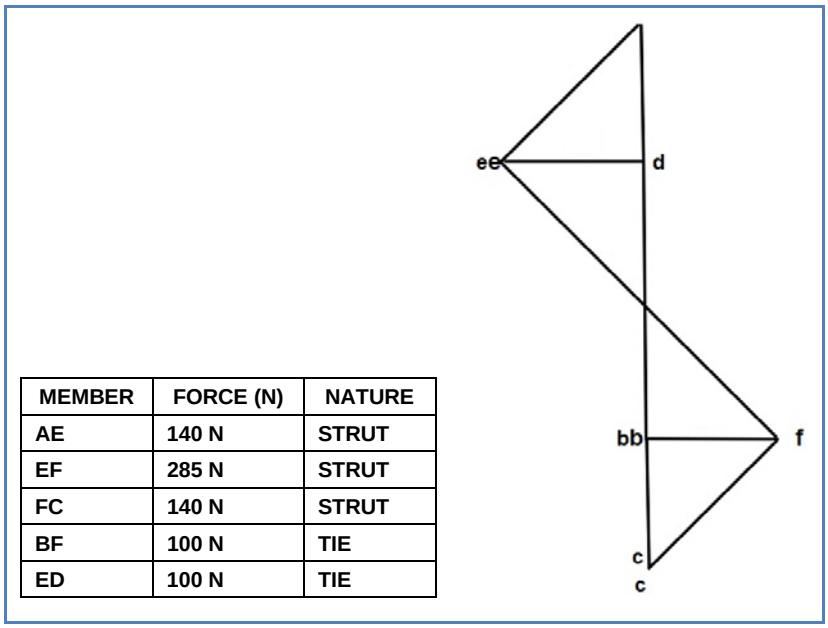
(Any 3 × 1)

6.4 It is the use of non-reusable electrodes to place a welding bead. Heating due to an electric current occurs through resistance to electric flow that arises between two metal plates. The heat produced melts the metal and develops a permanent joint.

QUESTION 7 FORCES (Specific)

7.1





MEMBER	FORCE (N)	NATURE
AE	140 N	STRUT
EF	285 N	STRUT
FC	140 N	STRUT
BF	100 N	TIE
ED	100 N	TIE

Note to markers: 7.1 and 7.2 must have a template drawn to scale to check the size of the drawings when marking the paper.

7.2 7.2.1 Moments LR

$$(RR \times 9) = (2 \times 4) + (2 \times 7) + (2 \times 8)$$
$$RR \times 9 = (8) + (14) + (16)$$
$$RR = \frac{38}{9}$$
$$RR = 4{,}2 \text{ kN}$$

Moments RR

$$(LR \times 9) = (4 \times 7) + (2 \times 2) + (2 \times 1)$$
$$LR \times 9 = (28) + (4) + (2)$$
$$RR = \frac{34}{9}$$
$$LR = 3{,}8 \text{ kN}$$

7.2.2 Bending moments (BM) at A and E is 0 N.m

BM by B = (3,8 × 2) – (4 × 0)
= 7,6 kN.m

BM by C = (3,8 × 7) – (4 x 5) – (2 x 0)
= 6,6 kN.m

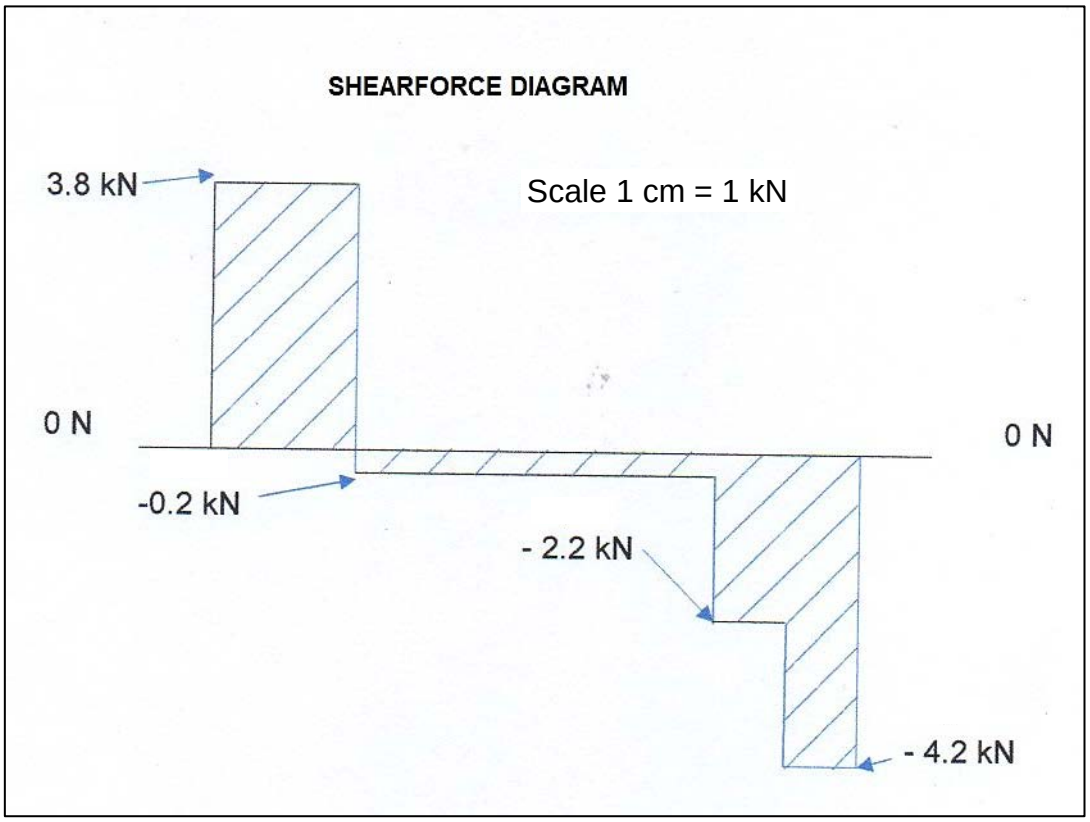
BM by D = (3,8 × 8) – (4 × 6) – (2 × 1)
= 4,4 kN.m

7.2.3 Shear forces at A and E is 0 KN

Shear forces at B 3,8 kN – 4 kN = -0,2 kN
Shear forces at C –0,2 kN – 2 kN = –2,2 kN
Shear forces at D –2,2 kN – 2 kN = –4,2 kN

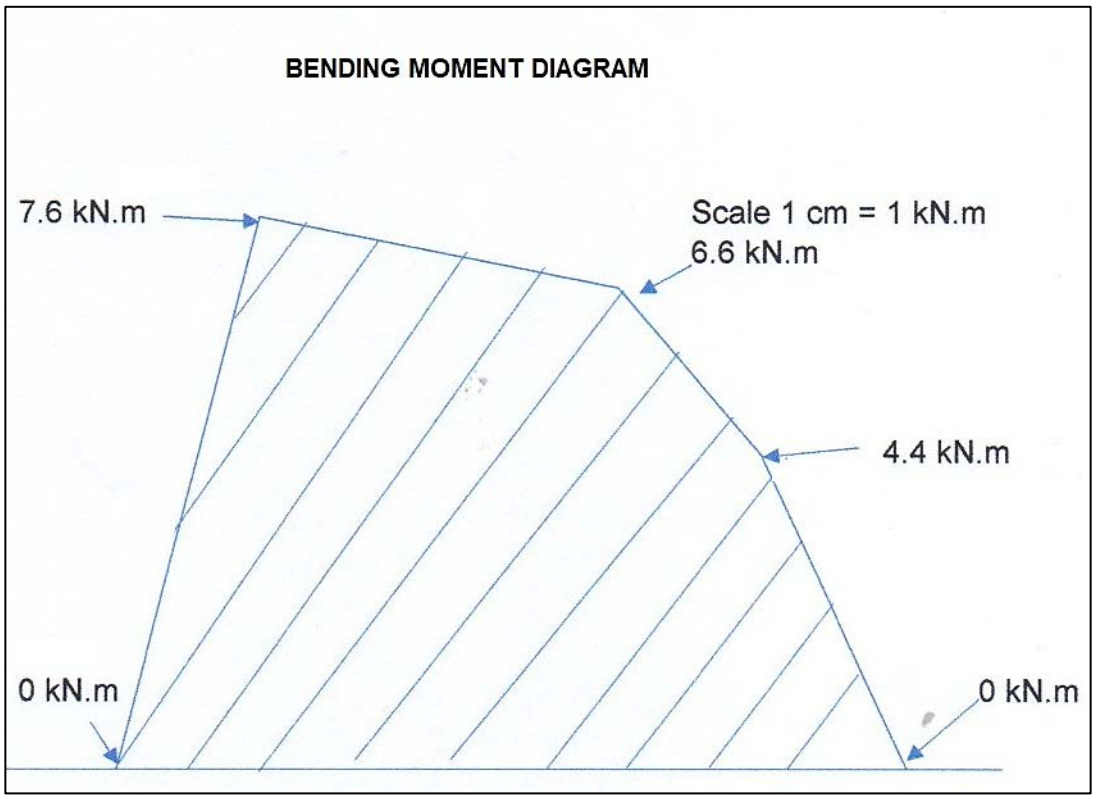
7.2.4 Scale 1 cm = 1 kN

Note to markers: 7.2.4 must have a template drawn to scale to check the size of the drawings when marking the paper.



7.2.5 Scale 1 cm = 1 kN.m

Note to markers: 7.2.5 must have a template drawn to scale to check the size of the drawings when marking the paper.



7.3 7.3.1 $\text{Stress} = \dfrac{\text{Load}}{\text{Area}}$

$$\text{Area} = \frac{\pi \times 10^2}{4}$$

$$\text{Area} = 0{,}00000078539 \text{ m}^2$$

$$\text{Stress} = \frac{150\ 000}{0{,}00000078539}$$

$$\text{Stress} = 190{,}098593 \text{ GPa}$$

7.3.2 $\text{Strain} = \dfrac{\text{Change in length}}{\text{Original length}}$

$$= \frac{0{,}6}{6\ 000}$$

$$= 0{,}0001$$

QUESTION 8 JOINING METHODS (Inspection of Weld) (Specific)

8.1 8.1.1
- Using well-maintained consumables.
- Ensure adequate shielding gas.
- Clean the joint properly.
- Slag must be removed before welding the next bead.
- Use correct travel speed.
- Use electrodes of the right size.
- Use the correct weaving action.

(Any 2 × 1)

8.1.2
- Aiming for a width-to-depth ratio of 1:1.
- Decreasing the current to reduce excess penetration.
- Decreasing welding voltage/current.
- Slowing travel speed.
- Reduce high carbon content in weld.
- Welding while joint is under stress due to joint design, use clamping devices.

(Any 2 × 1)

8.2 8.2.1 Measures flexibility of the welding joint and heat-affected zone of the welding joint. Measures the percentage extension of the weld metal

8.2.2
- After welding, the material is trimmed in the opposite direction of welding.
- Scratch two lines 1,6 mm on the edges of the welding bead and measure the distance.
- Bend the material first 30°.
- Measure the lines again and update percentage extension.

8.2.3
- A crack or tear of more than 1,6 mm appears during the test.
- Extension of the welding bead of more than 15%.

8.3
- Carburising
- Oxidising
- Neutral

8.4
- Make a hacksaw cut at both edges, through the centre of the weld.
- Place specimen on two steel supports.
- Use a sledgehammer to break the specimen in the area of the cuts.
- Inspect the exposed weld metal in the break for incomplete fusion, slag inclusion, etc.

8.5 8.5.1
- Cleaning the welding surface.
- Use dry electrodes.
- Avoid rust on electrode.
- Ensure that supply of shielding gas is not interrupted.
- Avoid welding in windy conditions.
- Use correct arc length

(Any 2 × 1)

8.5.2
- Set to correct current setting.
- Apply the correct electrode angle.
- Increase the travel speed.
- Use the correct root gap.
- Ensure the correct joint preparation.

(Any 2 × 1)

QUESTION 9 JOINING METHODS (Stresses and Distortion) (Specific)

9.1 Tension in the welding bead due to heat and cooling of the welding bead and heat-affected zone which causes deformation.

9.2 9.2.1 Specific steel application electrodes have thermal properties that differ from the parent metal's which can cause deformation if pre-heating is not done.

9.2.2
- Expulsion during heating could be opposed.
- Contraction during cooling could be opposed.
- Applied tension on the load could cause movement.
- Applied tension could not cause movement.

(Any 2 × 1)

9.2.3
- Do not over-weld
- Uninterrupted welding
- Place welds near the neutral axis
- Use as few runs as possible
- Use backstep-welding
- Provide shrinkage force
- Plan welding sequence
- Use a strongback

(Any 4 × 1)

9.3
- The prior amount of cold work.
- The temperature and time of annealing process.
- Composition of the metal.
- The melting point.

9.4 The grain formation will become uniform.

9.5
- Fused salts
- Water

QUESTION 10 MAINTENANCE (Specific)

10.1 10.1.1
- Driving motor will be damaged.
- Excessive strain on the driving system.
- The cutting blade will be damaged.
- The blade may deflect and result in a skew cut.

(Any 1 × 1)

10.1.2
- Result in malfunction due to excessive loads on the spindle bearings, grinding wheel and machine motor.
- Overloading will wear the grinding wheel excessively and unevenly.
- It shortens the lifespan of the spindle bearings and motor.

(Any 1 × 1)

10.2
- Due to the heat caused by friction, the cutting edge of the drill bit softens/ blunts.
- Lifespan of the drill bit will be reduced.

(Any 1 × 1)

10.3
- Maintenance staff confirms that machine is safe and operational.
- Check that all the guards and safety devices are in place.
- Inform workers that the machine is re-implemented.
- Check that the area around the machine is clean.
- Check all bolts and nuts.
- Check that all isolating devices have been removed.
- Turn on the power supply to the machine.
- Check to make sure the machine is working correctly and not making funny sounds.
- Make sure that there are no funny smells or excessive vibrations.
- Make sure the machine does not overheat.

(Any 5 × 1)

QUESTION 11 TERMINOLOGY (Development) (Specific)

11.1 A–1 $= \sqrt{450^2 + 150^2 + 750^2}$

$= 887,41 \text{ mm}$

11.2 **0 = X:**

$= 300 \times \cos 30°$

$= 259,807 \text{ mm}$

Outside-X:

$450 - 259,807 = 190,192 \text{ mm}$

X-2:

$= 300 \times \sin 30°$

$= 150 \text{ mm}$

2-Left side:

$= 450 - 150 = 300 \text{ mm}$

A-Below-2:

$= 190,192^2 + 300^2$

$= \sqrt{126172,9963}$

$= 355,208 \text{ mm}$

A-2:

$= 355,208^2 + 750^2$

$= \sqrt{688672,9969}$

$= 829,86 \text{ mm}$

11.3 **A-4-base**

$150^2 + 450^2 = (A\text{-4-base})^2$

$(A\text{-4-base})^2 = 474,34 \text{ mm}$

E-4-base

$(A\text{-4-base})^2 - A\text{-}E^2 = E\text{-}4^2$

$474,34^2 - 450^2 = E\text{-}4^2$

$= 149,99 \text{ mm}$

E-4 $= \sqrt{150^2 + 750^2}$

$= \sqrt{585\ 000}$

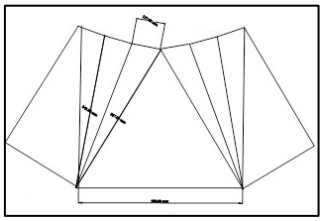
$= 764,852 \text{ mm}$

11.4 $= \dfrac{\pi D}{12}$

$= \dfrac{\pi 600}{12}$

$= 157 \text{ mm}$

11.5



Dimensions to be shown by candidates on drawing of development.

Total: 200 marks