These marking guidelines consist of 19 pages and Annexure A.
QUESTION 1: MULTIPLE-CHOICE QUESTIONS (GENERIC)

1.1 A ✓  
1.2 C ✓  
1.3 A ✓  
1.4 B ✓  
1.5 D ✓  
1.6 A ✓  

TOTAL QUESTION 1: [6]
QUESTION 2: SAFETY (GENERIC)

2.1 Angle grinder: (Before using)
- The safety guard must be in place before starting. ✓
- Protective shields must be placed around the object being grinded to protect the people around. ✓
- Use the correct grinding disc for the job. ✓
- Make sure that there are no cracks in the disc before you start. ✓
- Protective clothing and eye protection are essential. ✓
- Check electrical outlets and cord/plugs for any damages. ✓
- Ensure that lockable switch is disengaged. ✓
- Ensure that the disc and the nut are well secured. ✓
- Ensure that the removable handle is secured. ✓
- Remove all flammable material from the area. ✓
- Secure the work piece. ✓
(Any 2 x 1) (2)

2.2 Welding goggles:
- To protect your eyes against sparks ✓
- To protect your eyes against heat ✓
- To be able to see where to weld ✓
- To protect your eyes from UV rays / bright light ✓
- To protect your eyes from smoke ✓
(Any 2 x 1) (2)

2.3 PPE for Hydraulic press:
- Overall ✓
- Safety shoes ✓
- Safety goggle ✓
- Leather gloves ✓
- Leather apron ✓
- Face shield ✓
(Any 2 x 1) (2)

2.4 Workshop layouts:
- Process layout ✓
- Product layout ✓
(2)

2.5 Employer’s responsibility regarding first-aid:
- Provision of first-aid equipment ✓
- First aid training ✓
- First-aid services by qualified personnel ✓
- Any first aid procedures ✓
- Display first aid safety signs ✓
- First aid personnel must be identified by means of arm bands or relevant personal signage ✓
(Any 2 x 1) (2)

TOTAL QUESTION 2: [10]
QUESTION 3: MATERIALS (GENERIC)

3.1 Bending test:
• Ductility ✓✓
• Malleability ✓✓
• Britteness ✓✓
• Flexibility ✓✓

(Any 1 x 2) (2)

3.2 Heat-treatment:

3.2.1 Annealing:
• To relieve internal stresses ✓
• To soften the steel ✓
• To make the steel ductile ✓
• To refine the grain structure of the steel ✓
• To reduce the brittleness of the steel ✓

(Any 2 x 1) (2)

3.2.2 Case hardening:
• To produce a wear resistant surface ✓ and it must be tough enough internally ✓ at the core to withstand the applied loads.
• Hard case ✓ and tough core. ✓

(Any 1 x 2) (2)

3.3 Tempering process:
• To reduce ✓ the brittleness ✓ caused by the hardening process.
• Relieve ✓ strain ✓ caused during hardening process.
• Increase ✓ the toughness ✓ of the steel.

(Any 1 x 2) (2)

3.4 Factors for heat-treatment processes:
• Heating temperature / Carbon content ✓
• Soaking (Time period at temperature) / Size of the work piece ✓
• Cooling rate / Quenching rate ✓

(3)

3.5 Hardening of steel:
• Steel is heated to 30 – 50°C above the higher critical temperature. (AC₃) ✓
• It is then kept at that temperature to ensure (soaking) that the whole structure is Austenite. ✓
• The steel is then rapidly cooled by quenching it in clean water, brine or oil. ✓

(3)

TOTAL QUESTION 3: [14]
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**TOTAL QUESTION 4:** [14]
QUESTION 5: TERMINOLOGY (TEMPLATES) (SPECIFIC)

5.1 Template loft:
The template loft is separated from the workshop because…
• it is quieter.
• the lighting is better.
• all equipment is at hand.
• it is a permanent base.
• marking on the floor enhance accuracy.

(Any 2 x 1) (2)

5.2 Purpose of purlins:
• The purlins support the roof covering
• Stabilizes the trusses.

(Any 1 x 2) (2)

5.3 A steel ring calculation:

5.3.1 Dimensions of the required material:
Mean diameter = Outside diameter – plate thickness
= 880 – 50
= 830 mm

Mean circumference = \( \pi \times \text{Mean diameter} \)
= \( \pi \times 830 \)
= 2607.52 mm

2608 mm of 50 x 50 mm square steel bar is required to fabricate the ring.

(7)

5.3.2

(4)
5.4 **Resistance weld symbols:**

5.4.1 Spot weld ✓

5.4.2 Seam weld ✓

5.5 **Welding symbols:**

A. Tail ✓
B. Weld symbol (Fillet weld) ✓
C. Pitch of weld ✓
D. Site weld ✓
E. Arrow ✓
F. Weld all round ✓

TOTAL QUESTION 5: [23]
QUESTION 6: TOOLS AND EQUIPMENT (SPECIFIC)

6.1. Working Principles:

6.1.1 Guillotine:
- A bottom cutting blade is fixed horizontally. ✓
- With a top cutting blade moving downwards. ✓
- It is driven by an electric motor, flywheel, gearbox and axle ✓ by eccentric motion / action / hydraulic action. ✓
  OR
- It is activated manually by foot ✓ with lever action. ✓

6.1.2 Bending rolls:
- A bending roll has two fixed rollers next to each other rotating in unison (Manually or Electrical motor). ✓
- A third roller is adjustable, moving in between the two rollers. ✓
- The third roller applies downward pressure onto the metal. ✓
- That causes the metal to deflect and ultimately form the round shape desired. ✓

6.2. Regulators on gas cylinders:
Regulators reduce ✓ the cylinder pressure ✓ to operating or working pressure. ✓

6.3 Press machine:
- The press machine is used for installing ✓ or removing ✓ components on mechanical devices / machines. ✓
- To press ✓ profiles ✓ onto material ✓
  (Any 1 x 3) ✓

6.4 MIGS/MAGs welding process:
A – Weld pool / weld bead / molten metal ✓
B – Electrode wire / electrode ✓
C – Gas shroud / electrical contact / nozzle / contact tip ✓
D – Shielding gas ✓

TOTAL QUESTION 6: [18]
QUESTION 7: FORCES (SPECIFIC)

7.1 Forces in members:

SCALE: Vector diagram 1 mm = 5 N

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<th>MAGNITUDE</th>
<th>NATURE</th>
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<td>STRUT ✓</td>
</tr>
<tr>
<td>BF</td>
<td>135 N ✓</td>
<td>STRUT ✓</td>
</tr>
<tr>
<td>CG</td>
<td>317,5 N ✓</td>
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<td>FG</td>
<td>27,5 N ✓</td>
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<td>ED</td>
<td>130 N ✓</td>
<td>TIE ✓</td>
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<tr>
<td>EF</td>
<td>27,5 N ✓</td>
<td>TIE ✓</td>
</tr>
<tr>
<td>GD</td>
<td>160 N ✓</td>
<td>TIE ✓</td>
</tr>
</tbody>
</table>

NOTE:
Use a tolerance of 2 mm ± on the vector diagram.
= a tolerance of 10 N ± on the answer.
7.2 Bending moments:

7.2.1 Moments about RR

\[ RL \times 10 = (8 \times 8) + (4 \times 5) + (6 \times 2) \]

\[ RL = \frac{96}{10} \]

\[ RL = 9.6 \text{kN} \]

Moments about RL

\[ RR \times 10 = (6 \times 8) + (4 \times 5) + (8 \times 2) \]

\[ RR = \frac{84}{10} \]

\[ RR = 8.4 \text{kN} \]

7.2.2 Bending moments at point A, B, C, D and E:

Scale 2 mm = 1 kN.m

Moment at A = 0 kN.m

B = RL \times 2 = 19.2 \text{kN.m}

C = (RL \times 5) - (8 \times 3) = 24 \text{kN.m}

D = (RL \times 8) - (8 \times 6) - (4 \times 3) = 16.8 \text{kN.m}

E = (RL \times 10) - (8 \times 8) - (4 \times 5) - (6 \times 2) = 0 \text{kN.m}

7.2.3

NOTE:

Use a tolerance of 2 mm + and – on the bending moment diagram.
7.3 **Stress and strain:**

\[
A = \frac{\pi d^2}{4} \text{ ✓}
\]

\[
A = \frac{\pi (0.02)^2}{4} \text{ ✓}
\]

\[
A = 0.314 \times 10^{-3} \text{ m}^2 \text{ ✓}
\]

\[
\text{Stress} = \frac{\text{Load}}{\text{Area}} \text{ ✓}
\]

\[
\text{Load} = \text{Stress} \times \text{Area} \text{ ✓}
\]

\[
\text{Load} = (80 \times 10^6) \times (0.314 \times 10^{-3})
\]

\[
\text{Load} = 25,133 \text{ kN} \text{ ✓}
\]

**TOTAL QUESTION 7:** [45]
QUESTION 8: JOINING METHODS (WELD INSPECTION) (SPECIFIC)

8.1 Factors to be observed during oxy-acetylene welding:
- Correct flame for the work on hand. ✓
- Correct angle of welding torch and welding rod. ✓
- Depth penetration and amount of fusion. ✓
- The rate of progress along the joint. ✓
- The distance of the nozzle from the parent metal. ✓

(Any 2 x 1) (2)

8.2 Abbreviation 'HAZ':
Heat Affected Zone ✓

(1)

8.3 Causes of weld defects:

8.3.1 Spatter:
- Disturbance in the molten weld pool. ✓
- Too low welding voltages. ✓
- Too high welding current / amps. ✓
- Inadequate shielding gas flow. ✓
- Too fast travel speed ✓
- Arc length too long ✓
- Wet electrode ✓
- Wrong polarity ✓
- Arc length too short ✓
- Wrong included electrode angle ✓
- Wrong electrode used ✓
- Arc blow ✓

(Any 2 x 1) (2)

8.3.2 Undercutting:
- Too fast travel speed ✓
- Rapid solidification ✓
- Too low arc voltage ✓
- Arc length too long ✓
- Excessive welding current ✓
- Too slow movement over weld ✓
- Current / amps too high ✓
- Electrode too big ✓
- Wrong electrode ✓
- Wrong included electrode angle ✓
- Excessive weaving ✓
- Wrong joint design ✓

(Any 2 x 1) (2)
8.3.3 **Incomplete penetration:**
- Welding current too low ✓
- Too fast travel speed ✓
- Incorrect electrode angle ✓
- Poor edge preparation ✓
- Insufficient root gap ✓
- Electrode too big ✓
- Wrong electrode ✓
- No pre-heating done ✓
- Wrong shielding gas used ✓
- Too long arc ✓

(Any 2 x 1) (2)

8.4 **Types of cracks:**

8.4.1 **Transverse cracks:**
- Pre-heating the base metal ✓
- Using lower strength consumables / welding rod ✓
- Slow cooling after welding ✓
- Use clamping device. ✓
- Weld toward the unrestrained side of the weld. ✓

(Any 2 x 1) (2)

8.4.2 **Centreline cracks:**
- Ensure that width-to-depth ratio is 1:1. ✓
- Decrease the current to decrease excess penetration. ✓
- Decreasing welding voltage setting or slowing travel speed to achieve a flat to convex weld surface. ✓
- Use clamping device. ✓

(Any 2 x 1) (2)

8.5 **Differences between non-destructive and destructive tests:**
- Non-destructive test does not destroy the welded joint. ✓
- Destructive test destroys the welded joint. ✓

(2)

8.6 **Ultrasonic test:**
- No defects will occurs during a ultrasonic test ✓
- Detect internal ✓ flaws as well as surface flaws. ✓
- Porosity ✓
- Slag inclusions ✓
- Cracks ✓

(Any 1 x 2) (2)
8.7 **Nick break test for internal defects:**
- Slag inclusion ✓
- Porosity ✓
- Lack of fusing ✓
- Oxidised metal ✓
- Burned metal ✓

(Any 2 x 1)  (2)

8.8 **Machinability test:**
- To determine the hardness ✓ and strength ✓ of the welded joint.
- To determine ✓ the machinability. ✓

(Any 1 x 2)  (2)

8.9 **Visual requirements of welds:**
- Shape of the profile ✓
- Uniformity of the surface ✓
- Overlap ✓
- Free from any external defects ✓
- Penetration bead ✓
- Root groove ✓

(Any 2 x 1)  (2)

TOTAL QUESTION 8:  [23]
QUESTION 9: JOINING METHODS (STRESSES AND DISTORTION) (SPECIFIC)

9.1 Residual stress:
Residual stresses are stresses that exist ✓ in a metal after cooling / welding. ✓ (2)

9.2 Factors affecting grain size:
- The amount of cold work. ✓
- The temperature and time of annealing process. ✓
- The composition and constitution. ✓
- The recrystallisation temperature of cold worked metal. ✓
- The melting point. ✓ (Any 2 x 1) (2)

9.3 Quenching medias:
- Oil ✓
- Water ✓
- Sand ✓
- Air ✓
- Brine / Salt water ✓
- Lime ✓
- Liquid salts ✓
- Molten lead ✓
- Ash ✓ (Any 2 x 1) (2)

9.4 Weld distortion:
- Distortion in a weld results from the uneven expansion and contraction (warping) ✓ of the weld metal ✓ and adjacent base metal ✓ during the heating and cooling cycle ✓ of the welding process. (4)

9.5 Factors that affect distortion and residual stress:
- If the expansion that occurs when metal is heated is resisted ✓ then deformation will occur. ✓
- When contraction that occurs on cooling is resisted ✓ then a stress will be applied. ✓
- If this applied stress causes movement ✓ then distortion occurs. ✓
- If the applied stress does not cause movement ✓ then there will be residual stress in the welded joint. ✓ (Any 2 x 2) (4)

9.6 Result when metal is cooled rapidly:
- Rapid cooling of metal results in large temperature differences ✓ between the internal and external areas ✓ of the metal that set up stresses, ✓ which cause cracks ✓ on the surface.
- It will harden ✓ ✓ and the grain structure ✓ will change. ✓ (Any 1 x 4) (4)

TOTAL QUESTION 9: [18]
QUESTION 10: MAINTENANCE (SPECIFIC)

10.1 Reasons maintenance:
- Promote cost saving ✓
- Improves safety ✓
- Increases equipment efficiency ✓
- Fewer equipment failure ✓
- Improves reliability of equipment ✓

(Any 2 x 1) (2)

10.2 Lockout on machines:
To ensure that nobody can turn on the machine ✓ while maintenance is being carried out. ✓

(2)

10.3 Reasons for service records:
- Assist in the monitoring of the condition of the machines. ✓
- Assist in upholding warranties. ✓
- Assist in keeping a history of maintenance and repairs. ✓

(Any 2 x 1) (2)

10.4 Methods of reducing friction:
- By reducing both drill speed and feed speed. ✓
- By applying lubrication. (cutting fluid) ✓
- Use the correct drill bit ✓
- Drill a pilot hole ✓

(Any 2 x 1) (2)

TOTAL QUESTION 10: [8]
QUESTION 11: TERMINOLOGY (DEVELOPMENT) (SPECIFIC)

11.1 Use of transformers:
Transformers are used to connect ✓ ducting sections of dissimilar ✓ shapes to each other. ✓ (3)

11.2 On-centre hopper:

Off-centre hopper: (1)
11.3 **Truncated cone:**

![Diagram of a truncated cone]

11.3.1 **Base circumference:**

Circumference = \( \pi \times \) Base diameter

= \( \pi \times 1400 \)  

= 4398.23 mm

(3)
11.3.2 **Main radius (AC):**

Triangles ABC and CED has the same shape:

\[
\frac{AC}{DC} = \frac{BC}{EC}
\]

Thus \(\frac{AC}{DC} = \frac{BC}{EC}\) \(\checkmark\)

From where \(AC = \frac{BC \times DC}{EC}\) \(\checkmark\)

And \(CE = \frac{\text{Base Dia} - 800}{2}\) \(\checkmark\)

\(= \frac{1400 - 800}{2}\) \(\checkmark\)

\(CE = 300\) mm \(\checkmark\)

For: DC

\(DC^2 = DE^2 + CE^2\) \(\checkmark\)

\(DC = \sqrt{1200^2 + 300^2}\) \(\checkmark\)

\(DC = 1236,93\) mm \(\checkmark\)

 Rounded = 1237 mm

\(AC = \frac{BC \times DC}{EC}\)

\(= \frac{700 \times 1237}{300}\) \(\checkmark\)

\(= 2886,17\) mm \(\checkmark\)

 Rounded = 2886 mm \(\text{(10)}\)

11.3.3 **Small radius (AD):**

\(AD = AC - DC\) \(\checkmark\)

\(= 2886 - 1237\) \(\checkmark\)

\(AD = 1649\) mm (1649,24 mm) \(\checkmark\) \(\text{(3)}\)

**TOTAL QUESTION 11:** [21]

**GRAND TOTAL:** 200
Annexure A

Question 7.1

The CM need to redraw to check the scale and to photocopy it to a transparency.

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Question 7.2.3