

MECHANICAL TECHNOLOGY: WELDING AND METALWORK

Time: 3 hours

200 marks

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This question paper consists of 11 pages and a Formula Sheet of 1 page. Please check that your question paper is complete.
2. Read the questions carefully.
3. Answer ALL the questions.
4. Number your answers exactly as the questions are numbered.
5. Start EACH question on a NEW page.
6. Show ALL calculations and units. Round off final answers to TWO decimal places.
7. Candidates may use non-programmable scientific calculators and drawing instruments.
8. Take the value of gravity to be 10 m/s^2 .
9. All dimensions are in millimetres, unless stated otherwise in the question.
10. It is in your own interest to write legibly and to present your work neatly.
11. Use the criteria below to help you manage your time.

| QUESTION | CONTENT | MARKS | TIME (minutes) |
|---------------------------|---|------------|----------------|
| GENERIC QUESTIONS | | | |
| 1 | Multiple-choice questions | 6 | 6 |
| 2 | Safety | 10 | 10 |
| 3 | Materials | 14 | 14 |
| SPECIFIC QUESTIONS | | | |
| 4 | Multiple-choice questions | 14 | 10 |
| 5 | Terminology (Templates) | 23 | 20 |
| 6 | Tools and Equipment | 18 | 10 |
| 7 | Forces | 45 | 40 |
| 8 | Joining Methods (Inspection of welds) | 23 | 20 |
| 9 | Joining Methods (Stress and distortion) | 18 | 20 |
| 10 | Maintenance | 8 | 10 |
| 11 | Terminology (Development) | 21 | 20 |
| TOTAL | | 200 | 180 |

QUESTION 1 MULTIPLE-CHOICE QUESTIONS (Generic)

Various options are provided as possible answers to the following questions. Choose the correct answer and write the letter (A–D) next to the question number (1.1–1.6) in your ANSWER BOOK. Example: 1.7 A.

- 1.1 What is the purpose of the Labour Relations Act (LRA No 66 of 1995)?
- A The Act determines specific work hours.
 - B The Act emphasises the working relationship of employees and employers.
 - C The Act promotes non-discrimination in the workplace.
 - D The Act gives employees the right to be developed. (1)
- 1.2 The revolving warning lights on power-driven guillotines reduce the hazard ...
- A of entry to the rear of the machine.
 - B by stopping the ram or back gauge from moving.
 - C by protecting the operator from the moving ram.
 - D of getting the operator's body pinched between the back gauge and the connecting shaft. (1)
- 1.3 A disadvantage of process layout of machines is that ...
- A supervision is weak.
 - B there is less interruption in the flow of work when machines become defective.
 - C damage to fragile goods may result from extra handling.
 - D there is greater flexibility in the production process. (1)
- 1.4 During the spark test, low-carbon steel would produce the following spark pattern:
- A straight carrier lines with a yellowish colour
 - B short carrier lines with a whitish colour
 - C long carrier lines with a bright white colour
 - D curved carrier lines with a yellow colour (1)
- 1.5 Brine that is used for extreme cooling consists of ...
- A water and oil.
 - B water and salt.
 - C oil only.
 - D water only. (1)
- 1.6 Which one of the steels below is best suited for case hardening?
- A High-carbon steel
 - B Low-carbon steel
 - C Medium-carbon steel
 - D Extra-high-carbon steel (1)

[6]

QUESTION 2 SAFETY (Generic)

- 2.1 State TWO responsibilities of an **employer** regarding safety in the work-place. (2)
- 2.2 Why is it so important to determine an injured person's vital signs after an injury? (2)
- 2.3 Name TWO safety rules to be applied when using an angle grinder. (2)
- 2.4 Why should a workpiece be clamped securely when using a drill press? (2)
- 2.5 Why should the distance between the grinding wheel and tool rest not be more than 3 mm? (2)
- [10]**

QUESTION 3 MATERIALS (Generic)

- 3.1 A metal type can be determined by the sound it makes when it is tapped with a hammer or when dropped on the floor. What type of steel can be identified by the following sounds?
- 3.1.1 A loud and clear sound. (1)
- 3.1.2 A dull sound. (1)
- 3.2 Describe what *soaking* of a metal involves. (3)
- 3.3 Explain the process of *normalising* of steel during the heat-treatment process. (4)
- 3.4 Use two neat sketches to explain the differences in grain structure before and after heat treatment. (4)
- 3.5 What is a pyrometer? (1)
- [14]**

QUESTION 4 MULTIPLE-CHOICE QUESTIONS (Specific)

Various options are provided as possible answers to the following questions. Choose the correct answer and write the letter (A–D) next to the question number (4.1–4.14) in your ANSWER BOOK. Example: 4.15 A.

- 4.1 There are three types of templates, namely strip, flange and ...
- A cleat.
 - B gusset.
 - C web.
 - D truss. (1)
- 4.2 To calculate the angles of a triangle, what type of ratios are used?
- A Trigonometric
 - B Scientific
 - C Angular
 - D Mechanical (1)
- 4.3 The *lead* of a screw thread is the ...
- A distance from one crest to the next crest of a screw thread.
 - B distance between the crest and the root.
 - C distance a thread moves axially in one revolution.
 - D outside diameter minus the inside diameter. (1)
- 4.4 Which of the following components is a part of an angle grinder?
- A Safety guard
 - B Stand
 - C Tool rest
 - D Grinding-wheel dresser (1)
- 4.5 A resultant is a ...
- A single force that has the same effect as the rest of the system.
 - B single force that has the same effect as two forces.
 - C force that has a reversed effect on the main force.
 - D force that has a force opposite to the main force. (1)
- 4.6 The unit value of stress is:
- A Pa
 - B kN
 - C N.m.
 - D No unit (1)

- 4.7 Welding inspections are done to identify the following:
- A whether the welder is working.
 - B whether the steel is strong enough.
 - C whether there are welding defects.
 - D whether the welder should get paid. (1)
- 4.8 Which of the following tests is an example of a *non-destructive test*?
- A Nick break test
 - B Liquid dye penetrant test
 - C Guided bend test
 - D Machinability test (1)
- 4.9 Which of the following steps can be taken to prevent transverse cracks?
- A Quick cooling after welding
 - B Slow cooling of the welded joint
 - C Using the correct welding current
 - D Correct preparation of the welding joint (1)
- 4.10 Which of the following factors influences the rate of cooling of the metal during the weld process?
- A Weld metal thickness
 - B Amount of oxygen
 - C The current setting of the welding machine
 - D High heat input (1)
- 4.11 What is the responsibility of the employer who provides equipment for maintenance?
- A The employer is only required to supply basic equipment so that the employees can do a task.
 - B Switches are unlocked and not tagged to inform other workers that maintenance work is incomplete.
 - C All equipment supplied by the employer must be certified as safe to use and must be maintained.
 - D None of the above. (1)
- 4.12 What would the effect of overloading a hydraulic guillotine be?
- A Backrest will shift.
 - B Blade and hydraulic system can fail.
 - C Blade guards will break.
 - D None of the above. (1)

4.13 In **FIGURE 4.13**, use Pythagoras' theorem to calculate the length of line B–Z if Y–Z = 200 mm and B–Y = 500 mm.

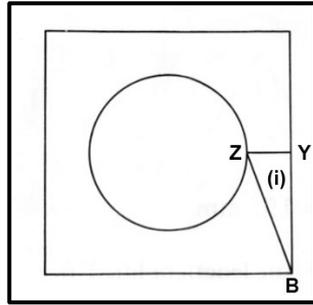


FIGURE 4.13

- A 439 mm
- B 422 mm
- C 539 mm
- D 522 mm

(1)

4.14 What formula would you use to calculate $\sin \beta$ in **FIGURE 4.14** below?

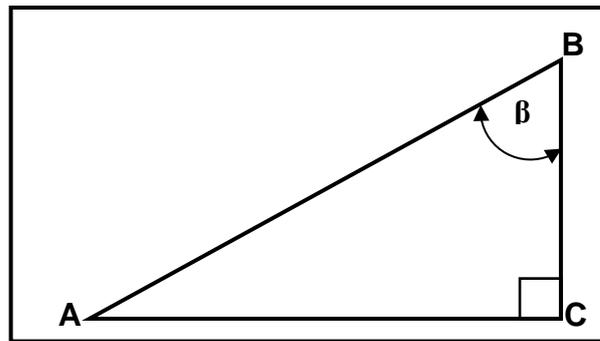


FIGURE 4.14

- A $\sin \beta = \frac{AC}{AB}$
- B $\sin \beta = \frac{BC}{AB}$
- C $\sin \beta = \frac{AB}{AC}$
- D $\sin \beta = \frac{AB}{BC}$

(1)

[14]

QUESTION 5 TERMINOLOGY (Templates) (Specific)

5.1 Regarding templates, what do the following two abbreviations stand for? (2)

5.1.1 T.S.U.

5.1.2 O.S.U.

5.2 What is the purpose of a web stiffener? (2)

5.3 What is the primary purpose of the purlins and why are they referred to as secondary members? (3)

5.4 **FIGURE 5.4** shows an illustration of a basketball net, bracket and hoop. Calculate how much material will be required to manufacture the following basketball hoop with an internal diameter of 400 mm, using 16 × 16 mm square bar.

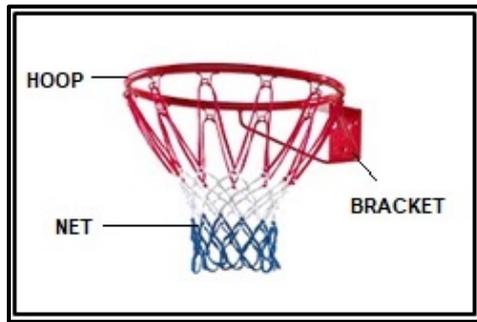


FIGURE 5.4

(6)

5.5 Draw the following welding symbols: (4)

5.5.1 Spot

5.5.2 Foil seam

5.5.3 Convex

5.5.4 Grind

5.6 Define *resistance welding*. (4)

5.7 When using welding symbols, what is the tail of the symbol used for? (2)

[23]

QUESTION 6 TOOLS AND EQUIPMENT (Specific)

6.1 Name TWO different types of tap wrenches. (2)

6.2 Label the sketch in **FIGURE 6.2** below. (9)

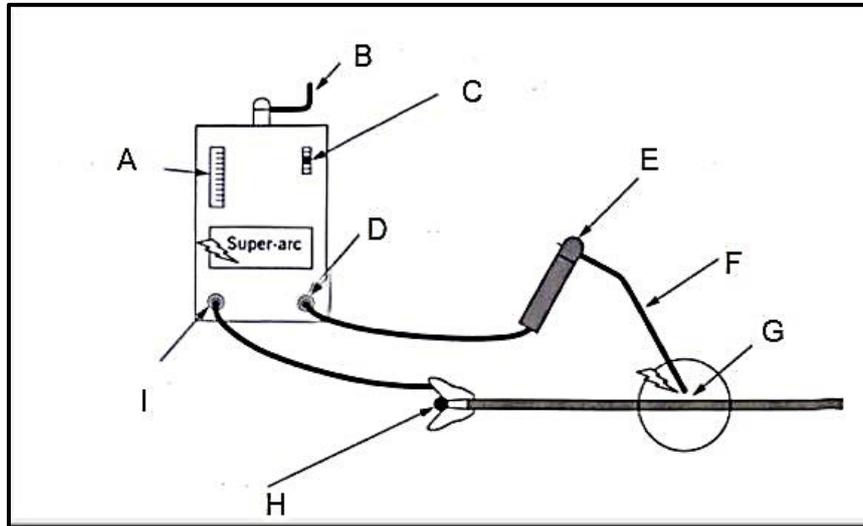


FIGURE 6.2

6.3 Briefly describe a punch and cropper machine and state what it is used for. (3)

6.4 What is a flashback arrestor and where is it fitted? (4)

[18]

QUESTION 7 FORCES (Specific)

7.1 Determine graphically the magnitude and nature of the forces in all the members in **FIGURE 7.1**.

SCALE: 1 cm = 10 kN

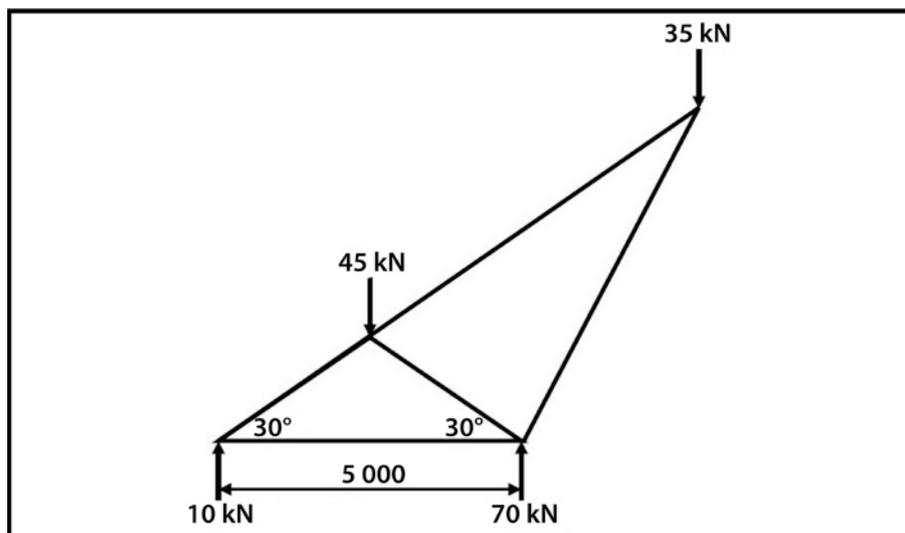


FIGURE 7.1

(15)

7.2 **FIGURE 7.2** shows a supported beam that is subjected to THREE vertical point loads of 8 N, 4 N and 3 N and a uniformly distributed load of 3 N/m exerted in the middle of the beam.

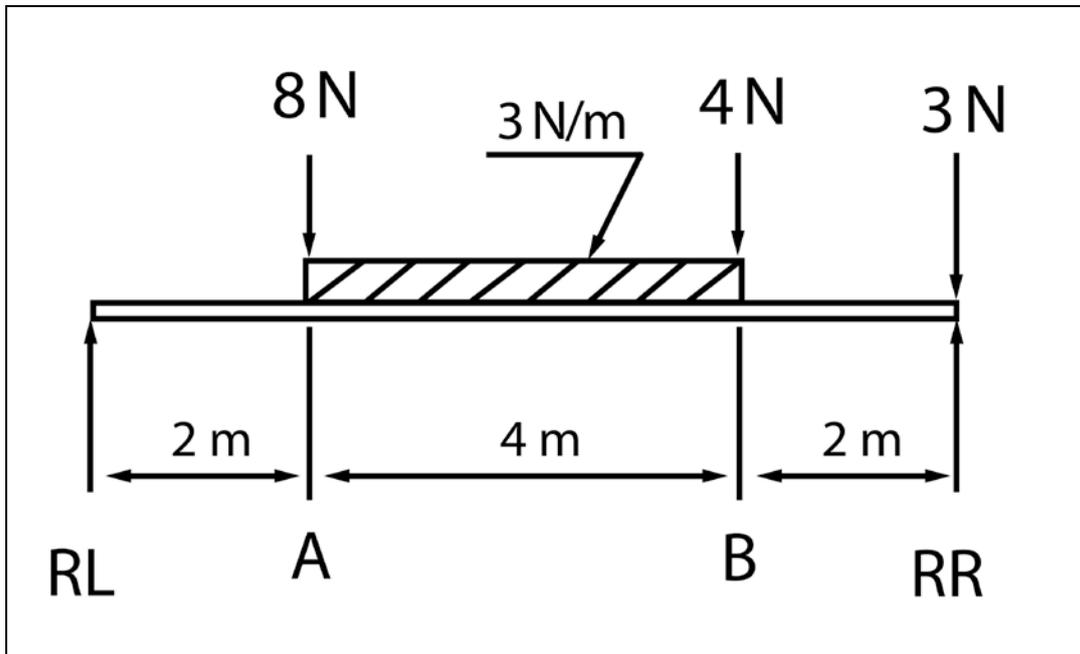


FIGURE 7.2

7.2.1 Calculate the reactions at the supports RL and RR. (6)

7.2.2 Calculate the bending moments at points A and B. (6)

7.2.3 Draw a shear-force diagram of the beam.

SCALE: 1 cm = 2 N (5)

7.2.4 Draw a bending-moment diagram of the beam.

SCALE: 1 cm = 2 Nm (4)

7.3 Calculate the compressive stress in a 20 mm round bar if it is subjected to a compressive load of 60 kN. (5)

7.4 Define the following concepts:

7.4.1 Load (2)

7.4.2 Strain (2)

[45]

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

- 8.1 Name three destructive tests exerted onto metals. (3)
- 8.2 Mention the FOUR different types of cracks found in welded joints and elaborate on what causes them. (8)
- 8.3 Demonstrate your understanding of the visual inspection process in welding by pointing out any THREE elements that should be inspected during the visual inspection process. (3)
- 8.4 Name THREE factors that should be observed during the arc-welding process to ensure a good welded joint. (3)
- 8.5 State TWO causes for each of the following during arc-welding:
- 8.5.1 Welding spatter (2)
- 8.5.2 Incomplete penetration (2)
- 8.6 Why would we do a free-bend test on a piece of metal? (2)
- [23]**

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

- 9.1 What factors control the rate at which metal cools down? (3)
- 9.2 One of the methods to reduce distortion is *intermittent welding*. Explain how this is done. (4)
- 9.3 What happens when austenite is allowed to cool slowly? (4)
- 9.4 Name THREE quenching media used to cool down steel. (3)
- 9.5 Describe the difference between cold working and hot working of steel. (4)
- [18]**

QUESTION 10 MAINTENANCE (Specific)

- 10.1 What is the safest and most efficient way to lubricate guillotine parts? (2)
- 10.2 With regard to plant and equipment maintenance, name TWO things that should never be ignored. (2)
- 10.3 Name the four general guidelines to be observed when maintaining a rolling machine. (4)
- [8]**

QUESTION 11 TERMINOLOGY (Development) (Specific)

FIGURE 11.1 indicates a hopper with a height of 350 mm, a base of 450 mm and a top of 900 mm.

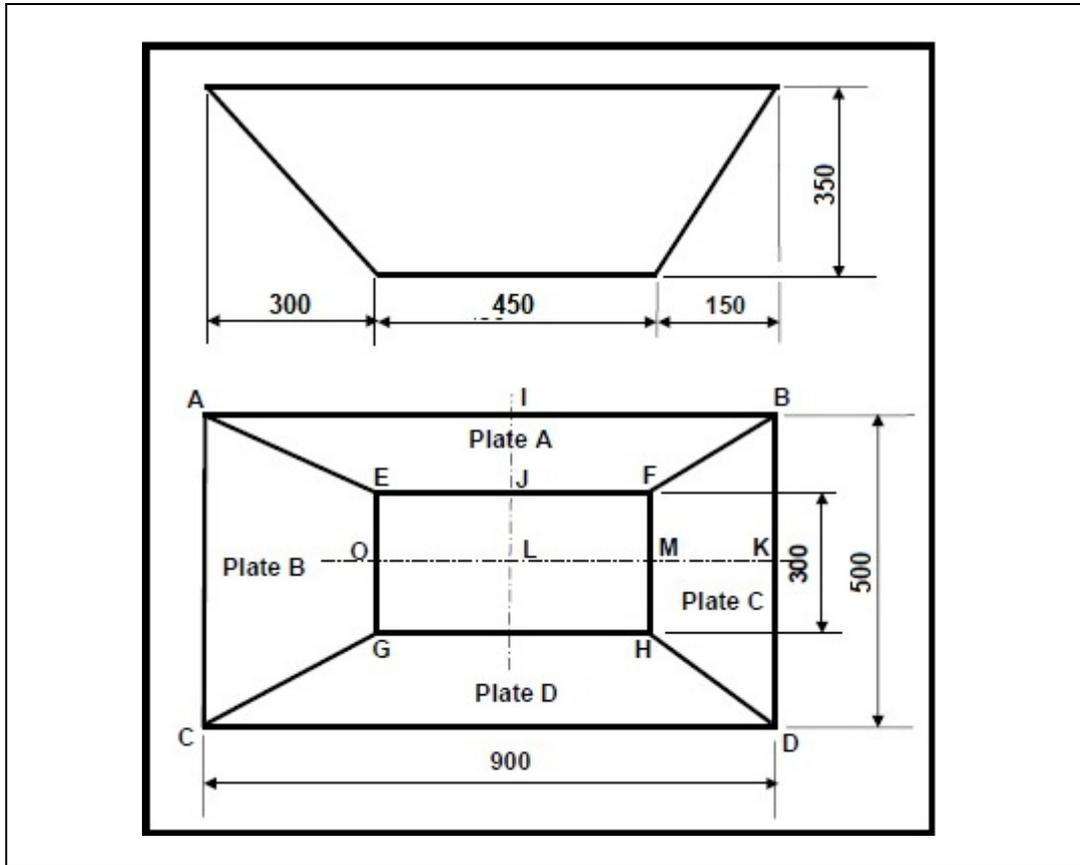


FIGURE 11.1

Calculate the following by referring to the diagram of the hopper above:

- 11.1 Calculate the length of IJ on plate A. (3)
- 11.2 Calculate the length of line AE on plate A. (6)
- 11.3 Calculate the length of MK on plate C. (3)
- 11.4 Calculate the length of DH on plate C. (6)
- 11.5 Calculate the length AF on plate A. (3)

[21]

Total: 200 marks