



Student Name: _____

2016
Assessment Task 4
Yearly Examination

Engineering Studies

General Instructions

- Reading time – 5 min
- Working time – 2 hrs

SECTION I

20 marks

Attempt questions 1 – 20.

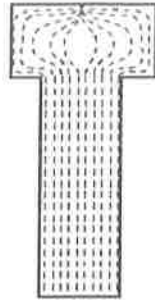
Allow about 30 minutes for this section.

Multiple Choice questions

Select the alternative A, B, C or D that best answers the question and indicate your choice with a (X) in the appropriate space on the grid below.

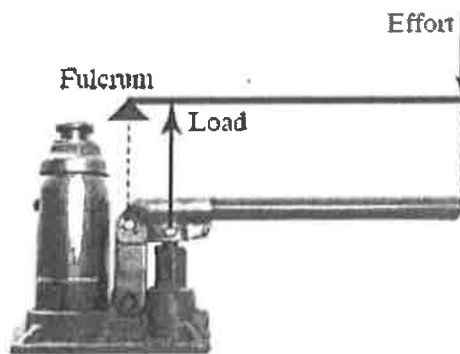
	A	B	C	D
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1. What is the name of the forming process that produces the grain flow shown below?



- (A) Forging
- (B) Casting
- (C) Drawing
- (D) Moulding

2. What is the order of the lever on the hydraulic jack shown below?



- (A) First order
- (B) Second order
- (C) Third order
- (D) Both B and C

3. A force of magnitude 100 kN acts upwards to the right at 60° to the horizontal. What is the horizontal component of the force?

- (A) 86.6 kN ←
- (B) 50 kN ←
- (C) 86.6 kN →
- (D) 50 kN →

4. Which two metals are alloyed to form bronze?

- (A) Copper and zinc
- (B) Copper and nickel
- (C) Copper and tin
- (D) Copper and lead

5. The heel of a lady's shoe has a diameter of 10 mm. Assume the total body weight of the lady is placed on the one heel only onto an aluminium alloy floor that is 0.5 mm thick with a shear stress of 50 MPa.

What minimum body mass will cause the heel to punch through the floor?

- (A) 65 kg
- (B) 79 kg
- (C) 85 kg
- (D) 90 kg

6. Which mechanical property of stone made it such a popular building material in ancient times?

- (A) High tensile strength
- (B) Aesthetically pleasing
- (C) High compressive strength
- (D) Good thermal conductivity

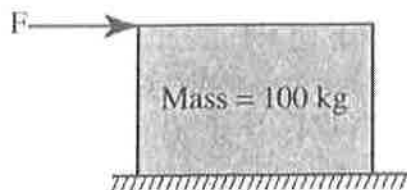
7. Which statement most accurately describes why alloys are stronger than the parent metal alone?

- (A) Alloys introduce new atoms in the crystal lattice which are generally stronger than the parent metal atoms
- (B) Alloys have foreign atoms in the crystal lattice which hinder slip and the movement of dislocations
- (C) Alloys introduce new atoms in the crystal lattice which provide more slip planes for increased ductility
- (D) Alloys have only one type of atom in the crystal lattice which results in a stronger metal than if there were different types of atoms present

8. What is the orthogonal projection recommended by AS1100?

- (A) 1st angle orthogonal projection
- (B) 2nd angle orthogonal projection
- (C) 3rd angle orthogonal projection
- (D) 4th angle orthogonal projection

9. A crate of mass 100 kg is just on the verge of sliding when a force F is applied as shown. What is the force F if the coefficient of friction between the two surfaces is 0.5? (Gravity = 10 m/s^2)



- (A) 500 N
- (B) 500 kg
- (C) 50 N
- (D) 100N

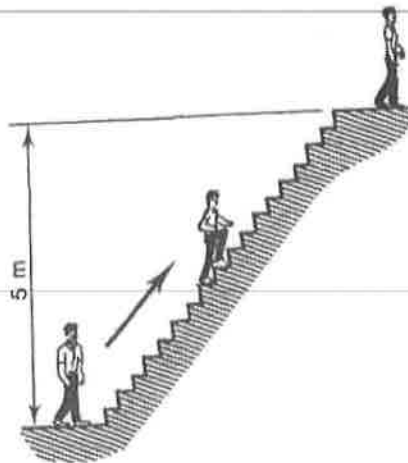
10. A tensile test piece has a gauge length of 0.16 m and extends 3 mm just before fracture during a tensile test. What is the value of strain for the tensile piece?
- (A) 18.75×10^{-3}
 - (B) 0.3 mm/m
 - (C) 6.7 mm/m
 - (D) 3×10^{-3}
11. Which statement describes the most suitable process for hardening a piece of 0.1% carbon plain carbon steel?
- (A) Heat to red heat and air cool
 - (B) Heat to red heat and furnace cool
 - (C) Heat to red heat and quench in water
 - (D) Cold working by rolling, hammering and/or bending
12. Which statement best describes Pascal's principle?
- (A) The buoyant force on a body immersed in a fluid is equal to the weight of the fluid displaced by that object
 - (B) The force on the input piston in a hydraulic system is always equal to the force applied by the output piston
 - (C) The distance moved by the input piston in a hydraulic system is less than that moved by the output piston
 - (D) Pressure applied to an enclosed liquid is transmitted equally throughout the liquid and to the walls of the container
13. Pearlite is a lamellar mixture of which two materials?
- (A) Ferrite and cementite
 - (B) Austenite and cementite
 - (C) Ferrite and martensite
 - (D) Austenite and martensite
14. Steel can be drawn into long thin wires and used in the construction of metal chain link fences. What percentage carbon content steel would be the most suitable for this application?
- (A) Up to 0.15%
 - (B) 0.2% to 0.3%
 - (C) 0.35% to 0.6%
 - (D) 0.65% to 1.0%

15. For the construction of a civil structure, many $\text{Ø}15\text{mm}$ holes need to be punched through the web of universal beams so that they can be bolted together. The web is 10mm thick and the web material has a shear strength of 500MPa .

Which capacity hydraulic ram is the most appropriate to apply the required punching force?

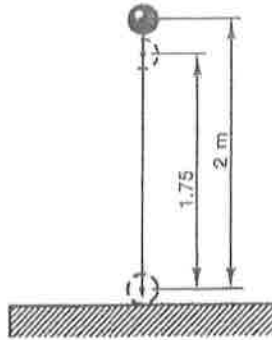
- (A) 100 kN
 - (B) 175 kN
 - (C) 230 kN
 - (D) 250 kN
16. Which statement best describes an allotropic material?
- (A) Exhibits the same strength properties in all directions
 - (B) Retains its structural form over a range of temperatures
 - (C) Exists in different structural forms at different temperatures
 - (D) Exists only as a eutectoid
17. Why does stainless steel have a high resistance to corrosion?
- (A) Atoms are ordered in a regular crystal lattice structure
 - (B) High chromium content produces a passive surface oxide film
 - (C) Carbon has a chance to precipitate during phase changes
 - (D) The lustrous surface resists the penetration of ultra violet rays and water

18. A man of mass 65 kg runs up a flight of stairs in 4 seconds . If the stairs have a total vertical rise of 5 metres , how much power did the man use? (Gravity = 10 m/s^2)



- (A) 812.5 watts
- (B) 812.5 joules
- (C) 81.25 watts
- (D) 81.25 joules

19. A steel ball bearing of mass 50 grams is dropped from a height of 2 metres on to a flat steel plate.
What is the kinetic energy of the ball bearing the instant before it hits the steel plate?
(Gravity = 10 m/s^2)



- (A) 1000 joules
(B) 100 joules
(C) 10 joules
(D) 1 joule
20. Which statement best describes the heat treatment process of annealing?
- (A) Heating to above 900°C and allowing to cool in air
(B) Heating to above 900°C and allowing to cool in a furnace
(C) Heating between 200°C and 600°C and then allowing to cool in air
(D) Heating to above 900°C and then cooling rapidly by immersing in water or oil

End of Section I

SECTION II

45 marks

Attempt questions 21 – 23.

Allow about 1 hour and 30 minutes for this section.

Answer the questions in the spaces provided. These spaces provide guidance for the expected length of the response.

Question 21 - (15 marks)



- (a) (i) Describe one significant safety problem that engineers had to solve in the design and/or production of the electric clothes iron shown above. 2

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- (ii) Explain how engineers solved the problem described in (i) above. 2

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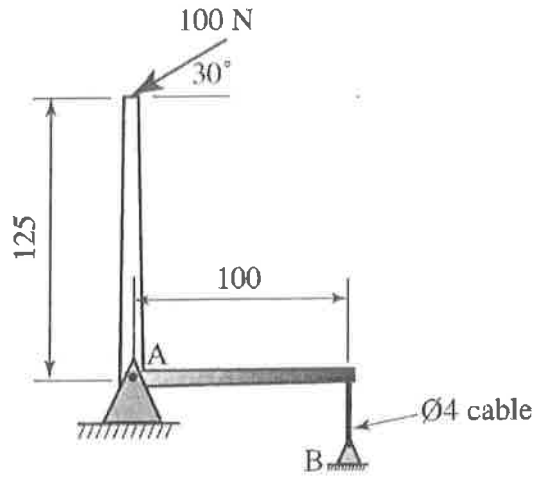
Question 21 continues on the next page

Question 21 (continued)

A right-angled lever pivoted at A, has a 100 N force acting at 30° as shown below. The horizontal arm of the lever is anchored at B by a $\text{Ø}4$ cable.

- (b) (i) Determine the force in the $\text{Ø}4$ cable when the 100 N force is applied.

3



Force in the $\text{Ø}4$ cable =

- (ii) Determine the stress in the $\text{Ø}4$ cable when the 100 N force is applied.

2

Stress in the $\text{Ø}4$ cable =

Question 21 continues on the next page

Question 21 (continued)

- (c) Explain the effects of hardening and tempering on the microstructure of a 0.6% carbon content steel mower blade. 2

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- (d) Identify a composite material and describe the functions of the components within its structure. 2

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Thermosoftening and thermosetting polymers have different structures.

- (e) Explain the difference between these structures using examples to support your answer. 2

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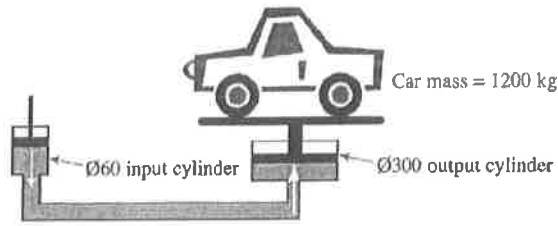
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End of Question 21

Question 22 – (15 marks)

A hydraulic car hoist supporting a car of mass 1200kg is shown below:

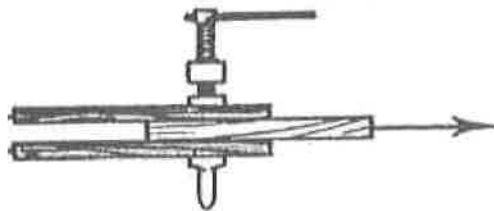


- (a) Calculate the input force required to support the car. 2

Input force required to support the car =

A clamp exerts a force of 500 N on three pieces of wood A, B and C, held together in equilibrium as shown below.

The coefficient of friction between the wooden pieces is 0.2.



- (b) What is the maximum tensile force P that can be applied to piece C before sliding occurs? 2

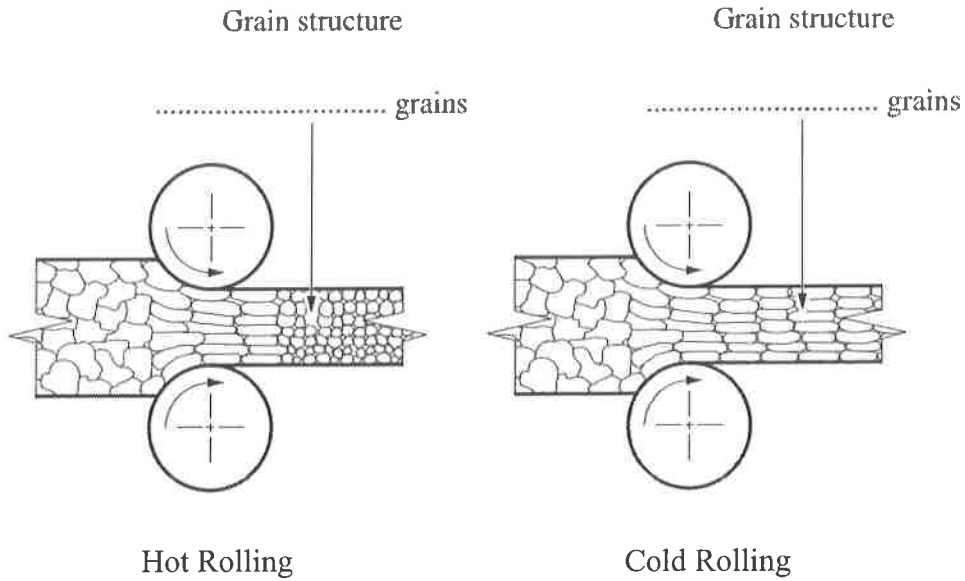
Tensile force **P** before sliding occurs =

Question 22 continues on the next page

Question 22 (continued)

Flat steel sheet metal can be produced by hot rolling or cold rolling.

- (c) (i) Complete the diagrams by labelling the grain structure produced for each process. 2



Choose one of the processes named in part (i).

- (ii) Explain how the change in grain structure caused by this process has affected TWO different mechanical properties of the steel. 3

Name of process:

Mechanical properties:

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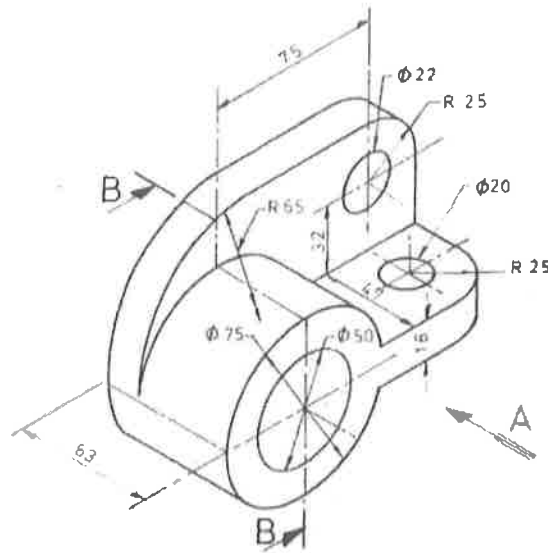
Question 22 continues on the next page

Question 22 (continued)

Details of a MS bracket are shown below in a pictorial drawing.

- (d) Using a scale of 1:1, draw a front view orthogonal representation of the bracket when looking in the direction of the A arrow. 6

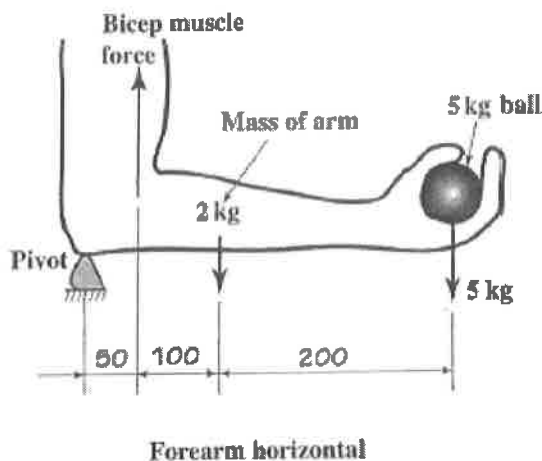
Dimension, using AS1100 standards, i) the diameter of one hole, and ii) the radius of one rounded corner.



End of Question 22

Question 23 – (15 marks)

A forearm, of mass 2 kg, is shown below supporting a dumbbell of mass 5 kg in a horizontal position.



- (a) Determine the force in the bicep muscle while supporting the 5 kg dumbbell. 2

Force in bicep when the forearm is horizontal =

A circular pad is to have a machine of mass 4000kg placed upon it.

- (b) Calculate the minimum diameter of this pad if the compressive stress in it is not to exceed 275 kPa. 2

Minimum diameter of the pad =

Question 23 continues on the next page

Question 23 (continued)

Biomedical engineers have a significant impact on our quality of life.

- (c) Considering social and ethical implications, examine the impact a biomedical engineer can have on the quality of life of a hip replacement recipient. 3

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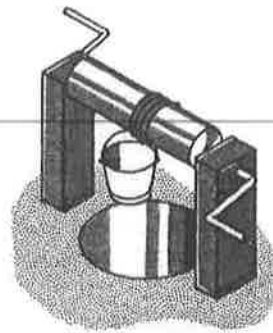
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The windlass shown below has a $\text{Ø}200$ winding drum that has a rope and load attached. The effort used to wind the load upwards is applied to the crank handles.



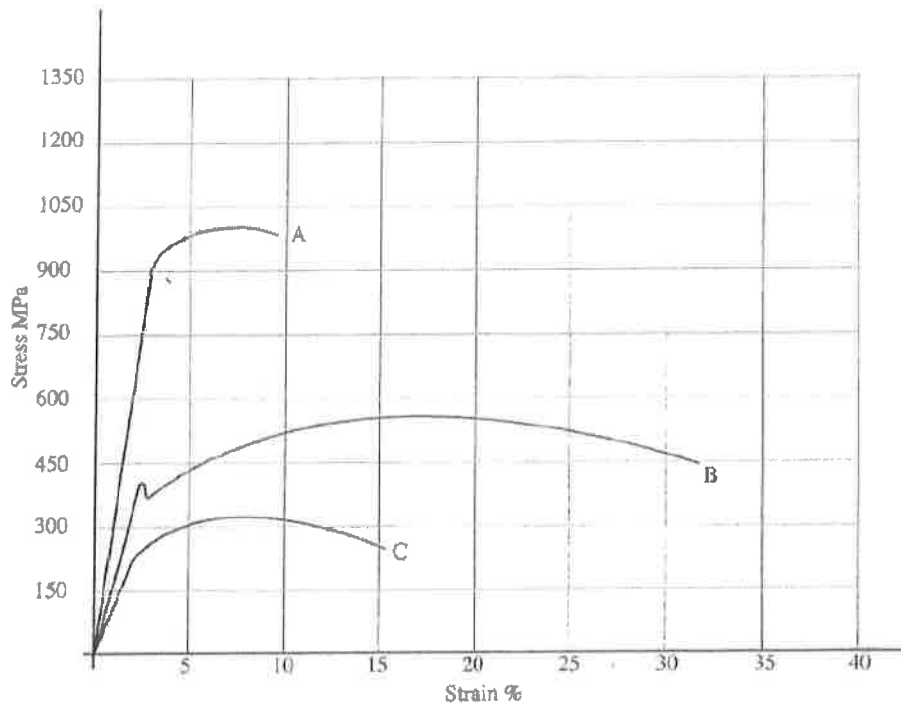
- (d) If the crank handles operate in a $\text{Ø}600$ path, determine the velocity ratio of this machine. You must show working. 2

Velocity ratio of this machine =

Question 23 continues on the next page

Question 23 (continued)

The diagram below shows tensile tests of three metallic samples, A, B and C.



- (e) Select the material, A, B or C that is most likely to be 0.1% carbon annealed steel giving one reason for your selection.

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Question 23 continues on the next page

Question 23 (continued)

Fatigue is the most common form of material failure.

- (f) Explain the mechanism of fatigue from initiation to failure. 2

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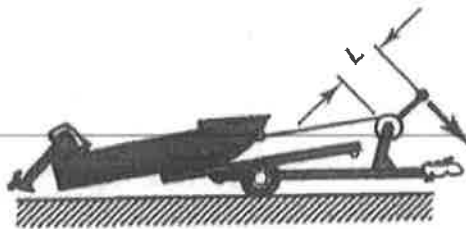
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- (g) Determine the suitable length, L , of the crank arm for the boat trailer winch if the winding drum plus the cables averages 60 mm in diameter and the tension in the cable does not exceed 1000 N with an input effort of 250 N. 2



Suitable length, L , of the crank arm =

End of Question 23

End of Exam