

2016 Yearly Exam

Thursday, 6 August 2020 7:05 AM

2016
Higher School Certificate
Preliminary Examination

Engineering Studies

General Instructions

- Reading time – 5 minutes
- Working time – 2 hours
- Board approved calculators may be used
- Write using black or blue pen
- Draw diagrams using pencil
- Write your student number and/or name at the top of every page
- A formula sheet is provided on the last page of this examination

Total marks – 65

Section I – Pages 2 – 6

Total marks (20)
Questions 1 – 20
Allow about 30 minutes for this section

Section II – Pages 7 – 15

Total marks (45)
Attempt Questions 21 – 23
Allow about 1 hour 30 minutes for this section

This paper MUST NOT be removed from the examination room

STUDENT NUMBER/NAME:

STUDENT NUMBER/NAME:

Section I**Total marks (20)****Attempt Questions 1 – 20****Allow about 30 minutes for this section**

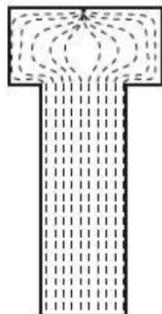
Select the alternative A, B, C or D that best answers the question and indicate your choice with a cross (X) in the appropriate space on the grid below.

	A	B	C	D
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1. Which parts of a sectioned orthogonal drawing should NOT be sectioned?

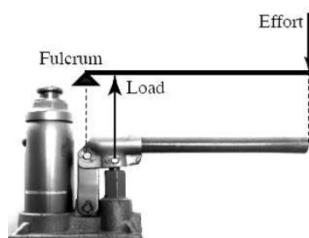
- (A) Welds, shafts, nuts, bolts, chamfers
- (B) Webs, nuts, bolts, shafts, washers
- (C) Spot facing, wheels, ribs, bolts, nuts
- (D) Tapped holes, fillets, nuts, keyways

2. What is the name of the forming process that produces grainflow as below?



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

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



- (A) First order
- (B) Second order
- (C) Third order
- (D) Fourth order

4. Why is reuse of commodities more beneficial than recycling to society and the environment?

- (A) Reuse saves disposal of commodities at land fill sites
- (B) Reuse requires less time, pollution, energy and cost than recycling
- (C) Reuse produces more attractive products than recycling but costs more
- (D) Reuse requires more energy than recycling but you can use products immediately

5. Bolts in an engineering drawing have a thread shown as: M20 x 2.0.
Which statement correctly identifies the bolts?

- (A) Metric thread profile, 20 mm diameter bolt, 2.0 mm thread pitch
 (B) 2 bolts required with a metric thread and 20 mm long
 (C) 20 bolts required with a metric thread and 2.0 mm washer thickness
 (D) Metric thread, 20 mm head thickness, 2.0 mm thread depth
6. 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 \leftarrow
 (B) 50 kN \leftarrow
 (C) 86.6 kN \rightarrow
 (D) 50 kN \rightarrow
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. Which is the best indicator of the toughness of a material on a stress/strain diagram?
 (A) The slope or gradient of the straight line section of the diagram
 (B) The value of the ultimate tensile strength (UTS)
 (C) The total area under the curve of the stress/strain diagram
 (D) The value of yield or proof stress on the stress/strain diagram
9. What is 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 an hydraulic system is always equal to the force applied by the output piston
 (C) The distance moved by the input piston in an hydraulic system is less than that moved by the output piston
 (D) Pressure applied to a confined liquid is transmitted equally throughout the liquid

Page 4

STUDENT NUMBER/NAME:

10. Which best describes the purpose of the earth connection in domestic electrical systems?
 (A) To protect against insulation failure within an appliance
 (B) To allow the electric charge to complete the circuit
 (C) So that the electrical circuit can cope with power surges
 (D) To protect the circuit during lightning strikes

11. The heel of a ladies shoe has a diameter of 0.10. Assume the total body weight is placed on the heel on a floor of 0.5 mm thick aluminium alloy with a shear strength 50 MPa. What body mass will punch the heel through the floor?

- (A) 500 kg
- (B) 392.7 kg
- (C) 78.5 kg
- (D) 50 kg

12. 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

13. Which metals are alloyed to form bronze?

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

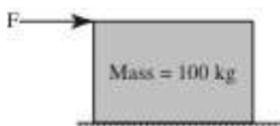
14. What was one main reason why stone was such a popular building material in ancient times?

- (A) Stone has a high tensile strength
- (B) There was no other available material
- (C) Stone has a high compressive strength
- (D) Stone was easy to mine and transport over long distances

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15. 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?



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

16. A tensile test piece has a gauge length of 0.16 m and extends 30 mm just before fracture

..... during a tensile test. What is the value of strain for the tensile piece?

- (A) 18.8 %
- (B) 0.3 m/m
- (C) 6.7 mm/m
- (D) 1.5 %

17. What type of brake has been replaced by disc brakes in domestic automobiles?

- (A) Band brakes
- (B) Drum brakes
- (C) Lever brakes
- (D) Servo assisted brakes

18. Which is the unit of resistance?

- (A) Volt
- (B) Ampere
- (C) Watt
- (D) Ohm

19. Which statement best describes the hardening 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, bending

20. Which is the most biocompatible material?

- (A) Titanium
- (B) Steel
- (C) Copper
- (D) Cast iron

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Section II

Total marks (45)

Attempt Questions 21 – 23

Allow about 1 hour 30 minutes for this section

Answer the questions in the spaces provided.

Question 21 (15 marks)

Marks

Communication is an essential skill in all areas of engineering.

- (a) Explain four reasons why it is important for today's engineers to be good communicators.

4

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Project management is an important area of professional engineering.

- (b) Describe the role of a project manager for an engineering project of your choice. 2

Question 21 continues on the next page

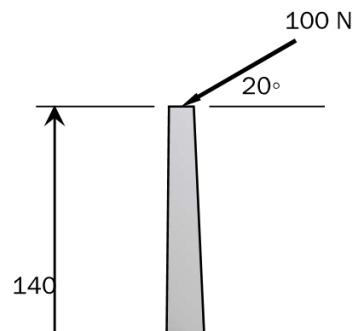
Page 7

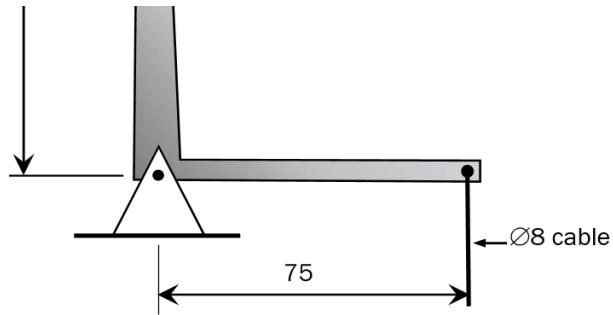
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Question 21 (continued) Marks

A right-angled lever pivoted at A, has a 100 N force acting at 20° is shown. The horizontal arm of the lever is anchored at B by a Ø8 cable.

- (c) (i) Determine the force in the Ø8 cable when the 100 N force is applied. 3





Force in the Ø8 cable =

Question 21 continues on the next page

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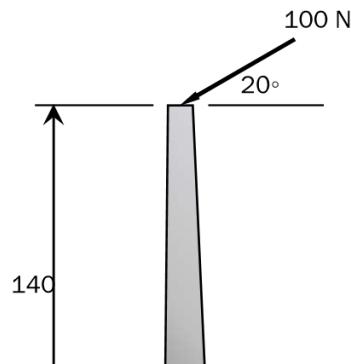
Question 21 (continued)

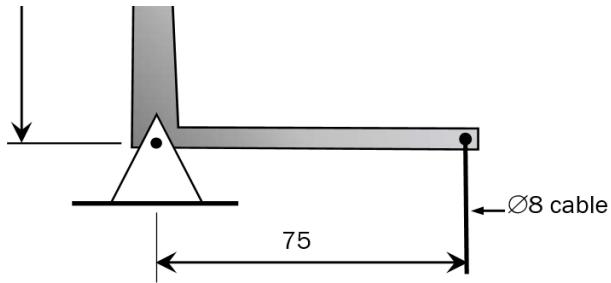
Marks

(ii) Determine the stress in the Ø8 cable when the 100 N force is applied. **2**

Stress in the Ø8 cable =

(iii) Determine the magnitude, sense and direction of the reaction force in the pivot at A when the 100 N force is applied. **4**





Magnitude of reaction force in pivot at A =

Sense and direction of reaction force in pivot at A =

End of Question 21

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STUDENT NUMBER/NAME:

Question 22 (15 marks)

Marks

Ceramics are generally hard, brittle and good insulators of heat and electricity when compared to metallic materials.

- (a) Explain, in terms of structure, why ceramics are generally harder and better insulators of electricity than metals. 4

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Copper wire used for electrical circuits is coated with a polymer for insulating purposes.

- (b) Name the common polymer that is used for coating copper wire and describe the process used to produce the coating. 2

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Question 22 continues on the next page

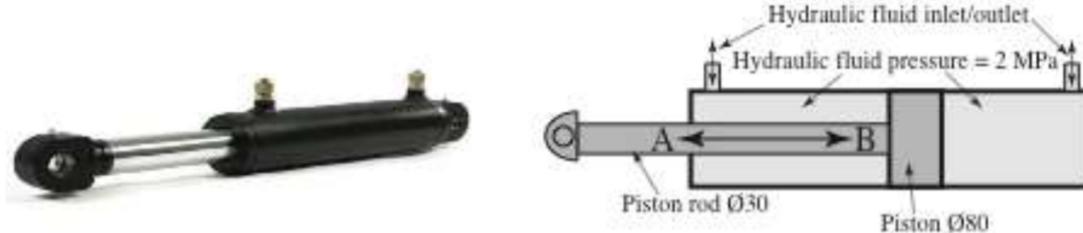
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Question 22 (continued)

Marks

A schematic drawing and picture of a double acting hydraulic cylinder are shown. The cylinder has a Ø80 piston and a Ø30 piston rod and operates on a fluid pressure of 2 MPa.



- (c) Calculate the force in direction A and the force in direction B when the hydraulic fluid pressure is 2 MPa.

4

Force in direction A =

Force in direction B =

Question 22 continues on the next page

Question 22 (continued)

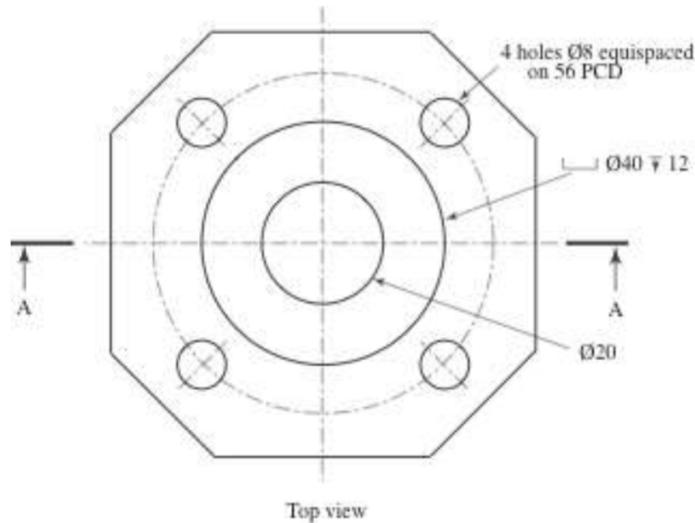
Marks

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A top view and a partially completed front view of a locking cap are shown.

- (d) Project a half sectional front view of the locking cap using the partially completed view provided. 5



End of Question 22

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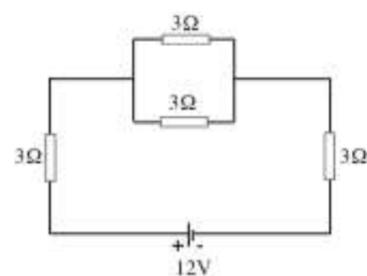
Question 23 (15 marks)**Marks**

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

- (a) Considering both costs and benefits, examine the impact biomedical engineers have on society. 4

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An electronic circuit is shown:



- (b) Calculate the total resistance of the circuit. 2

Total resistance of the circuit =

Question 23 continues on the next page

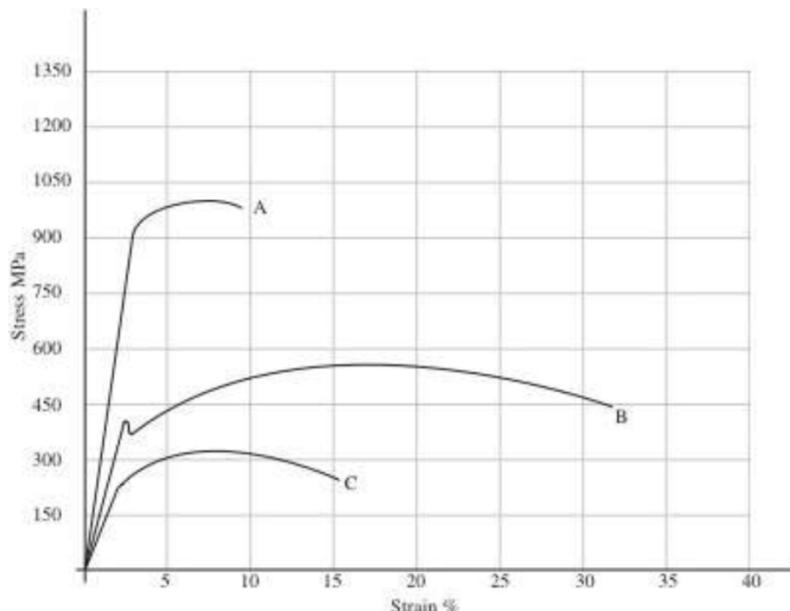
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Question 23 (continued)

Marks

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



- (c) (i) Select the metal, 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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- (ii) Select the stiffest metal by circling one of the following: A, B, C

1

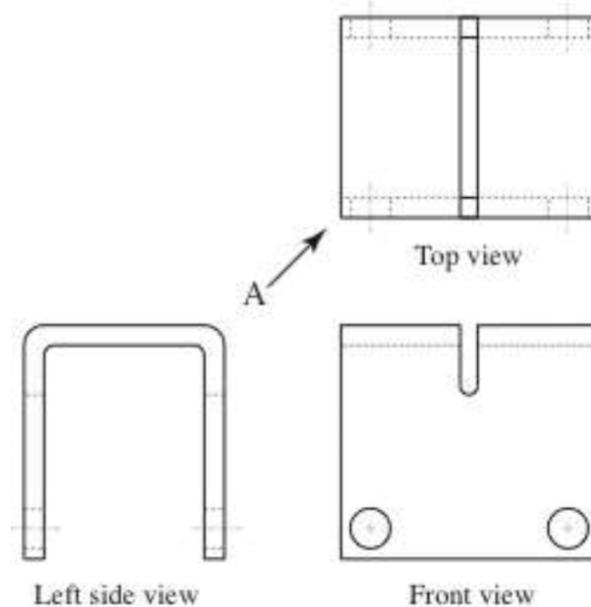
Question 23 continues on the next page

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Question 23 (continued)

Marks

- (d) A U-shaped engineering component is drawn below in orthogonal projection.
Taking sizes from the orthogonal drawing sketch a pictorial drawing of the component so
that it is viewed from arrow A. 6

**End of paper**

STUDENT NUMBER/NAME:

FORMULAE SHEET**Force, Moments**

$$F = ma; \quad M = Fd$$

If a body is in equilibrium, then $\sum F_x = 0; \quad \sum F_y = 0; \quad \sum M = 0$

Friction

$$F = \mu N; \quad \mu = \tan \phi$$

Energy, Work, Power

$$KE = \frac{1}{2}mv^2; \quad PE = mgh; \quad W = Fs = \Delta PE + \Delta KE; \quad P = \frac{W}{t}; \quad P = \frac{Fs}{t}$$

Pressure

$$P = \frac{F}{A}; \quad P = P_o + \rho gh$$

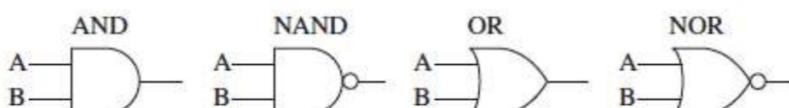
Stress and Strain

$$\sigma = \frac{F}{A}; \quad \epsilon = \frac{e}{L}; \quad E = \frac{\sigma}{\epsilon}; \quad \sigma = \frac{My}{I}$$

$$\sigma_{\text{allowable}} = \frac{\sigma_{\text{yield}}}{F \text{ of } S} \text{ (Ductile);} \quad \sigma_{\text{allowable}} = \frac{\sigma_{UTS}}{F \text{ of } S} \text{ (Brittle)}$$

Machines

$$MA = \frac{L}{E}; \quad VR = \frac{d_E}{d_L}; \quad \eta = \frac{MA}{VR}$$

Digital electronics**Electricity, Electronics**

$$E = IR \quad P = I^2R$$

$$\text{Series } R_t = R_1 + R_2 + R_3 + R_4 + \dots + R_n$$

$$\text{Parallel } \frac{1}{R_t} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4} + \dots + \frac{1}{R_n}$$