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UNIVERSITY OF BOLTON

SCHOOL OF THE BUILT ENVIRONMENT & ENGINEERING

RAK CAMPUS

BEng (Hons) in Mechanical Engineering
BEng (Hons) in Automobile Engineering
BSc (Hons) Motor Vehicle & Transport Studies

SEMESTER 2 EXAMINATION 2009/2010

MATERIALS AND MANUFACTURE II

MODULE NO: ATT2015

Date: Friday, 4 June 2010 **Time:** 13.00 – 15.00

INSTRUCTIONS TO CANDIDATES:

There are two parts to this paper; PART A and PART B.

Each part contains 3 questions.

Answer 2 questions from PART A and 2 questions from PART B.

All questions carry equal marks.

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PART A

Q1. Shown in Figure 1 are two photographs of a medium duty chainsaw for heavy gardening and general use, but not forestry. The saw retails for ~£160 and is used for cutting small trees and branches up to 250mm diameter. Casual and professional gardeners use such saws and they would be expected to last for around 10 years depending on usage. Replacement parts are available from the manufacturer such as the saw chain, the guide blade and, perhaps other parts.

Figure 1

For the components labelled above:

a. In a few words, describe the purpose of each component. (4 marks)

b. State the material properties and characteristics that would be required for the component to fulfil its role both during manufacture and in use. (8 marks)

c. For each component, suggest the probable material that is used and, if steel, state the percentage carbon content and possible other alloying elements that might be used. (8 marks)

Question 1 continued over

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Question 1 continued

d. State the method and briefly describe the process by which the Body Cover is manufactured. Also state the reasons why this component is best manufactured in this way. (5 marks)

Total 25 marks

Q2.

a) Define what is meant by the term 'Fibre Reinforced Composite Material'. (6 marks)

b) Give two advantages and two disadvantages of using composite materials. (4 marks)

c) A unidirectional composite material is made up of two materials; the fibre has a Tensile Modulus of 75GPa and the Resin has a Tensile Modulus of 4GPa. If the Volume Fraction of reinforcement is 0.7, determine the Tensile Modulus in the direction of lay of the composite material. (6 marks)

d) Sintered Aluminium Powder (SAP) is regarded as a composite material. Describe the properties of this material in comparison with Pure Aluminium and Al/Cu alloys (Duralumin). (9 marks)

Total 25 marks

Q3.

A machine tool body and frame for a medium size lathe is to be manufactured. It is one of 1000 such machines that are to be made in the next twelve months. The body and frame consists of slide-ways, body panels and reinforcement all in one integral component and has internal voids to reduce weight and material usage.

a) Name a typical material that would be used to manufacture this component and state the reasons for your choice. (5 marks)

b) Name the manufacturing method that would be used to make the initial geometry of the component and state the reason for using this method. (7 marks)

c) Describe a method by which the slide-ways on the lathe bed would be made to be wear resistant. (8 marks)

d) Name a test that could be performed on the slide-ways that would indicate whether they are suitable to resist wear and state the units or a scale in which the figures would be given. (5 marks)

Total 25 marks

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PART B

Q4.

a) A team of designers and manufacturing engineers is attempting to specify a material and process for a component that needs to be light, rigid and cheap to produce in large quantities.

The material will need to be able to form complex shapes with thin walls (~1.5 mm) and need minimal secondary processing and finishing.

It is expected that the component be recyclable at the end of its life with minimal loss of material and need for additional energy.

The team is considering three materials: an Aluminium-Zinc alloy, Polypropylene ("PP") and glass-and-chalk-filled Polyester Resin ("DMC").

To help the team with its selection, use your knowledge of material properties to draw up a table in which you compare the APPROXIMATE and RELATIVE characteristics of the PP and DMC with those of the Aluminium-Zinc alloy.

Have regard to:

- Density (specific gravity)
- Ductility
- Appropriate primary process(es)
- Need for secondary finishing
- Suitability for thin-walled complex parts
- Recyclability

Note that precise numbers are not needed – indications such as "higher/lower", "better/worse", etc., are enough.

(15 marks)

b) Take ONE of the primary manufacturing processes indicated in your table and describe, with diagrams where helpful, the PRINCIPAL features of the process.

Summarise the process in terms of its need for energy, the complexity of shape that it can produce and the range of materials that can be processed. (10 marks)

Total 25 marks

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Q5.

a) In a particular product intended for everyday consumer use, the following components are found as part of its operating mechanism:

- A hairpin (torsion) spring that oscillates through an angle of 15° at a rate of 5Hz
- A lever that transmits the torque of the spring to the face of a rotating cam
- A plain bush in which the lever is supported during its oscillation
- A cam follower which connects the lever to the cam
- A rotary cam against which the follower runs

The parts are shown schematically in Fig Q5a.

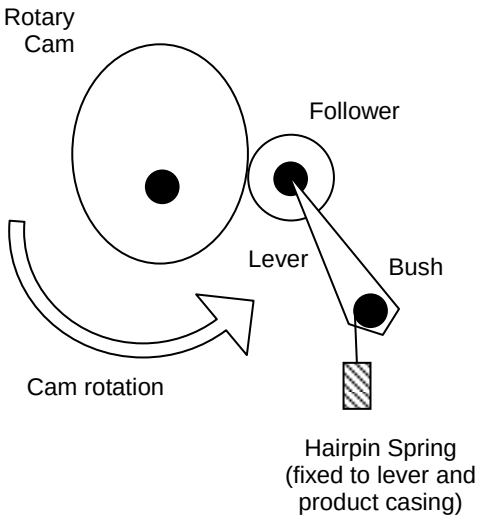

Figure Q5a – schematic of mechanism parts

- For EACH of the five parts listed, indicate TWO physical properties that would be important to its proper function (10 marks)
- For any ONE of the parts, indicate the type of information you might seek if you were a manufacturing engineer expected to specify a material and production process. (5 marks)

Question 5 continued overleaf

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Question 5 continued

b) A part having a total volume of 1 litre is expected to have the following capabilities:

- Operate in temperatures between -30°C and +200°C
- Withstand static tensile stresses of up to 250MPa with no permanent deflection
- Withstand dynamic fluctuating stresses of up to ±100MPa for 10^8 cycles
- Require no additional finishing, coating or plating
- Be suitable for processing from solid billet on conventional machines with "High Speed Steel" tooling.
- Weigh no more than 8kg

It has been suggested that the part be made from 6061-T6 Aluminium Alloy. Selected properties of the alloy are shown in Table Q5b below.

	Aluminium 6061-T6	
Fatigue Strength	96.5 MPa	(5 x 10^8 cycles)
Yield Strength	276 MPa	(0.2% proof stress)
Density	2.76 g/cm^3	
Ageing Temperature	175°C	

Table Q5b – Selected properties of 6061-T6 Aluminium Alloy
(Source: MatWeb)

Comment on the suitability of this material in this application, and if appropriate and possible, suggest an alternative. If you think an alternative is suitable, give reasons.

(10 marks)

Total 25 marks

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Q6.

a) An assembled product ("Product X") has 5 types of component part; some types are used more than once. The parts are assembled as follows:

- Part A is placed into a holding fixture
- Two (2) units of Part C are used to secure one (1) unit of Part D on to Part A to form Subassembly SA
- Two (2) units of Part B are snapped into place on Subassembly SA to form Subassembly SB
- Two (2) further units of Part C are welded to Subassembly SB to form Subassembly SC
- Subassembly SC is removed from the fixture
- One (1) unit of Part E is snapped into place on EACH side of Subassembly SC to form the finished product, Product X.

Draw a "Family Tree" diagram or Indented Bill of Materials showing the logical relationship between the components of the assembly.

(10 marks)

b) Selected characteristics of the individual parts are shown in Table Q6b.

	Part A	Part B	Part C	Part D	Part E
Material	Aluminium	Steel	Steel	PA6-GF30	HDPE
Weight, g/part	100	20	15	25	10
Material Cost, £/part	2.5	0.8	0.15	0.1	0.025
Labour cost, £/part	10	0.5	0.75	0.01	0.05
Carbon footprint, g/part	1000	250	275	150	100

TableQ6b – Part details

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Question 6 continued

Using relevant data from Table Q6a, calculate the following:

- The material cost of one unit of Subassembly SB, in £. (6 marks)
- The total Carbon Footprint of one unit of Product X, in grams. (9 marks)

You may assume all assembly to be automated – i.e. zero labour cost at the assembly/sub-assembly level.

Total 25 marks

END OF QUESTIONS