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UNIVERSITY OF BOLTON

RAK CAMPUS

SCHOOL OF THE BUILT ENVIRONMENT & ENGINEERING

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

SEMESTER 2 EXAMINATION 2010/2011

MATERIALS AND MANUFACTURE II

MODULE NO: ATT2015

Date: **Friday, 3 June 2011** **Time:** **13.00 a.m. – 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 – Answer any TWO questions

Q1. Figure Q1 below shows a labelled cut-away view of an electric motor. All the main parts are shown.

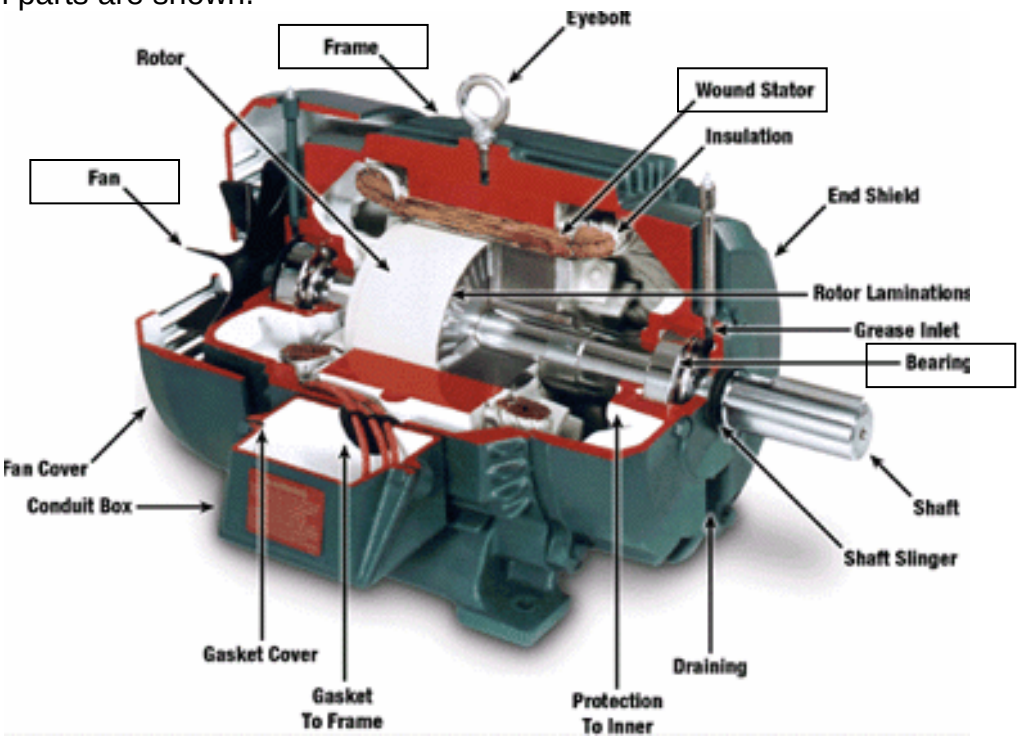

Figure Q1

For the four components framed in boxes (i.e. the motor Frame, the Outer Ring of the Rolling Element Bearing, the Wound Stator and the Fan):

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

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

c. Suggest the probable material that would be used for each of the four components and, if steel, state the percentage carbon content and possible other alloying elements that might be used. (7 marks)

d. State a possible method of manufacture of the Fan component and state the reasons why the Fan component would be manufactured in this way. (6 marks)

Total 25 marks

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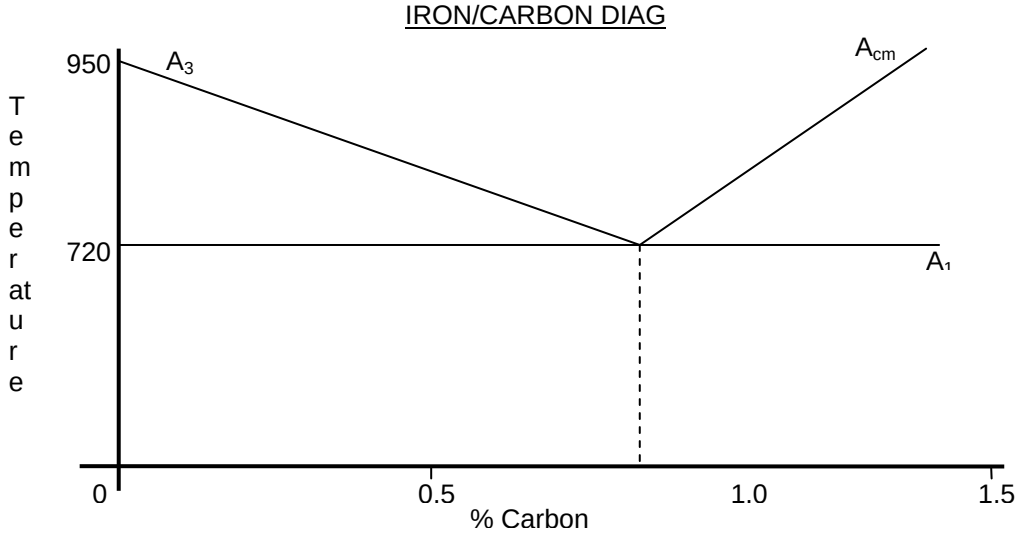
Q2.

a) A 0.4% Carbon Steel is 'soaked' in a furnace at 850^{0}C for a period of time. The furnace is then switched off and left to cool down to room temperature with the steel component left inside.

With the help of the Iron/Carbon Diagram below, describe the cooling of the steel component in terms of the crystalline structural changes that take place, the temperatures at which they occur and the make-up of the resulting structure of the material at room temperature. (8 marks)



b) State the name of the process outlined in (Q2 a)), describe the final properties of the material after this treatment and state why this is so. (5 marks)

c) Name four different methods of producing a hard, wear resistant surface, on a steel component. (4 marks)

d) State the meaning of the following standard steel code:

080M40 (3 marks)

e) If a 0.6% Carbon Steel is cooled rapidly from above its A_3 temperature, describe the final structure and properties of the material at room temperature. Also, if the material has not produced a uniform structure across its cross-section (different structure in the middle), state what might or might not have occurred during cooling. Use the correct terminology in your descriptions. (5 marks)

Total 25 marks

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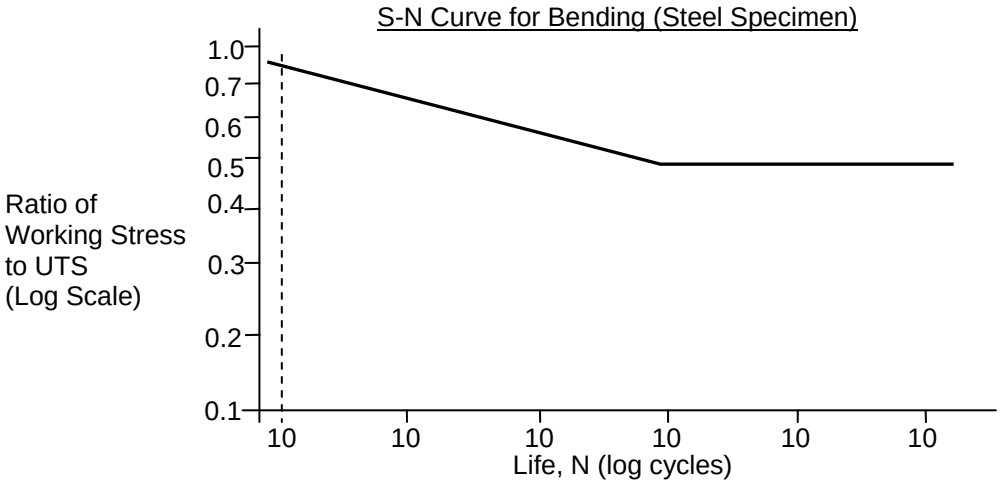
Q3. Figure Q3 below shows the arrangement of a cantilever fin attached to a machine body. A point load P acts at the end of the fin.

Figure Q3

Load P is an intermittent load and is applied and removed every 15 seconds. The fin is in continual operation for 8 hours per day, 5 days per week, 48 weeks per year and is expected to function for at least 5 years. When P is applied, the resulting bending moment produces a bending stress at the shoulder (where the fin joins the body) of 150MPa.

a. State whether or not the beam is acting at its 'endurance limit' and write down the reasons for your statement. (4 marks)

b. Using the chart below, determine the Ultimate Tensile Strength of the material that would be chosen for the fin so that it should not fail during service. (4 marks)



c. Outline the options available when designing and manufacturing a part that will undergo fatigue stress so as to help prevent fatigue failure. In particular, what could be done to the fin to prevent fatigue cracks from forming? (6 marks)

Question 3 continued over

Question 3 continued

d. Describe the mechanism by which fatigue cracks form and extend, leading to fatigue failure of a component. (6 marks)

e. Describe, in words and sketch, the appearance of a typical fatigue failure of a circular section shaft. (5 marks)

Total 25 marks

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PART B – Answer any TWO questions

Q4. A simple assembled product ("Product Z") consists of two types of subassembly and one final assembly, with six types of component part.

Table Q4 summarises selected information about the product and its parts.

Item	Unit of Measure	Used on (parent)	Quantity per parent	Material cost per unit of measure	Labour cost per assembly
Product Z	Ea	-	-	-	1.20
Subassembly A	Ea	Z	1	-	2.00
Subassembly B	Ea	Z	2	-	0.05
Part C	Ea	A	1	.05	-
Part D	ml	A	5	.02	-
Part E	Ea	A	2	0.10	-
Part F	g	B	5	0.50	-
Part G	Ea	B	1	0.10	-
Part H	Ea	B	3	0.01	-

Table Q4 – parts used in Product Z

a) Using a simple diagram or intended BOM, indicate graphically the relationships between the parts, the subassemblies and the final product.

(8 marks)

b) Calculate the total labour cost, the total material cost and overall total direct product cost for Product Z. Clearly explain your method.

(12 marks)

c) Using a similar method, indicate how you might estimate the carbon footprint for a single unit of Product Z. ***Note: you don't have to calculate the carbon footprint precisely – just indicate your method, with a sample calculation using values that you estimate yourself.***

(5 marks)

Total 25 marks

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Q5.

a) Briefly point out THREE benefits and THREE drawbacks of **INJECTION MOULDING**

(6 marks)

b) Outline the principal features of the injection moulding process, having particular attention to:

- Materials suited to the process
- Part tooling requirements and fixed start-up costs
- Production quantity and individual item costs

(6 marks)

With respect to the high-production part shown in Figure Q5c:

- Point out at least THREE problems that might be encountered when trying to injection-mould this part (6 marks)
- Suggest a method by which EACH of them might be overcome. (3 marks)
- Indicate the general area (using a simple sketch) where the ejector pins might be located relative to the tooling and part (2 marks)

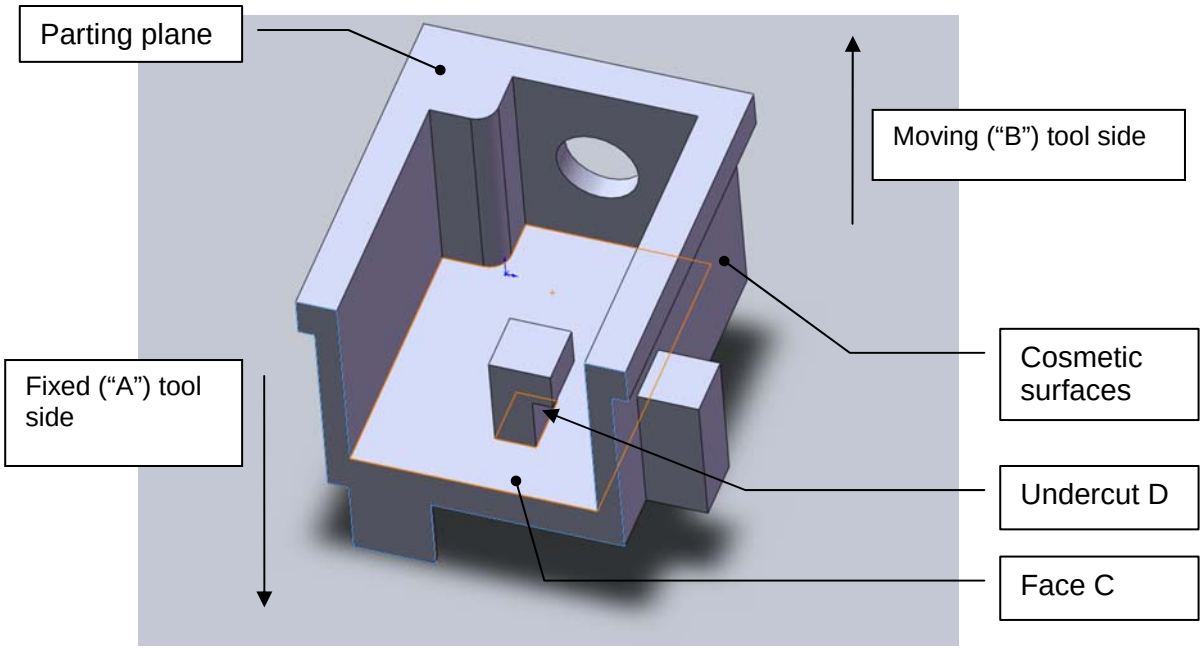

Figure Q5c – Partial sectioned view of part to be injection moulded

Question 5 continued over

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Question 5 continued

- If the face at C might be interrupted (i.e. not a continuous surface), what might you do to ease the manufacture of the undercut at D?

(2 marks)

Total 25 marks

Q6. A one-off component is required to resist steady vertical loads and fluctuating horizontal loads, such that the positions of the loading bosses remain constant in horizontal and vertical planes relative to a fixed base.

Figure Q6 shows the loading arrangements and the principal dimensions and magnitudes of the forces involved.

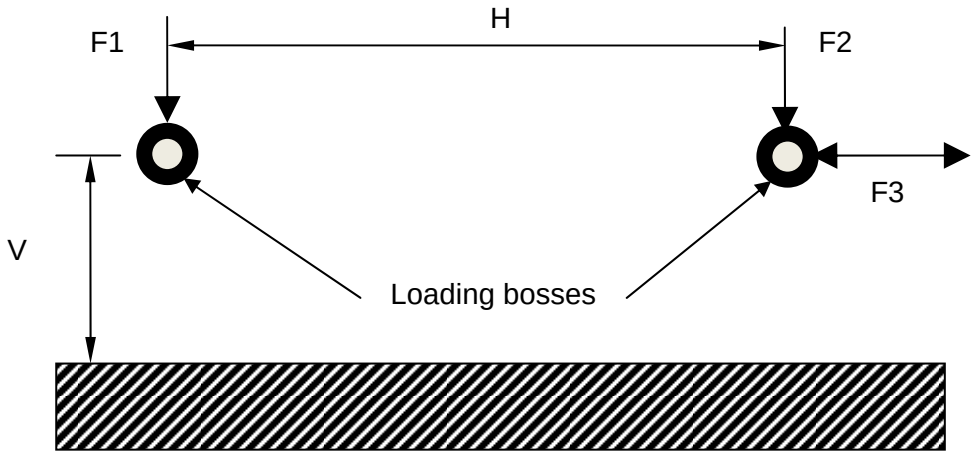

Figure Q6 – Forces and dimensions

Question 6 continued over

Question 6 continued

a) In the original case, V=1200mm and H=1500mm. F1 = F2 = 10 kN, while F3 fluctuates slowly (at less than 0.5Hz) between +/- 2kN.

There are no significant forces normal to the plane of the sketch.

With a simple sketch, make a suggestion for a fabricated mild steel assembly that would resist these loads. In particular, pay attention to:

- The cross-section of the material that you might use
- The number and position of members in the assembly
- The means by which the members might be joined

Note that there is no need to perform any stress calculations here.

(15 marks)

b) In a similar but smaller case, the loads and dimensions are smaller, but the production quantities are much higher – between 10,000 and 50,000 parts.

In this new smaller case,

V = 120mm, H = 150mm, F1 = F2 = 100N and F3 = +/-20N

Suggest a material and manufacturing method for this new case, having regard to the production quantities and revised dimensions.

(5 marks)

Sketch your revised part showing the component shape and main features.

(5 marks)

(Total 25 marks)

END OF QUESTIONS