[ENG30]

UNIVERSITY OF BOLTON

SCHOOL OF ENGINEERING

MSc MECHANICAL ENGINEERING

SEMESTER TWO EXAMINATION 2023/2024

MECHANICS, MATERIALS AND MANUFACTURE PROCESSES

MODULE NO: AME7009

Date: Friday 17th May 2024 **Time: 10:00 – 12:00**

INSTRUCTIONS TO CANDIDATES: **There are SIX questions in total.**

There are TWO sections with THREE questions in each.

Answer ANY TWO questions from each section. There are total of FOUR questions to answer.

All questions carry equal marks of 25. Marks for parts of questions are shown in brackets.

Electronic calculators may be used if necessary.

A formula sheet is provided following the questions.

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Section1: Manufacturing

Q1. Additive Manufacturing (AM)

a) In recent years, additive manufacturing (AM) has been increasingly replacing conventional manufacturing (CM). What are the key differences between CM and AM?

(10 marks)

b) As a subset of powder bed fusion (PBF) technologies in additive manufacturing (AM), selective laser melting (SLM) primarily employs metal powders. Can you explain the workflow of SLM, detailing how it manufacture metal parts within this specific context?

(10 marks)

c) What factors influence the quality of parts produced by fused deposition modeling (FDM), and why do they matter? Additionally, identify three areas where FDM technology is commonly applied.

(5 marks)

Total 25 Marks

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Q2. Material Cutting and Forming Processes

a) Metal cutting plays a crucial role in manufacturing, shaping parts to precise dimensions and finishes. Could you describe the system used for metal cutting? Additionally, explain how a conventional lathe operates? List five examples of lathe machining features.

(10 marks)

b) In the realm of manufacturing, materials undergo various processes to become finished products, two of which are metal cutting and metal forming. Could you explain the difference between these two processes and provide five examples of each?

(10 marks)

c) Die casting is a widely used manufacturing process that moulds metal under high pressure into complex shapes and fine details, making it essential for producing components in various industries. Could you outline the step-by-step process of die casting, including relevant diagrams to illustrate each step, and also identify four common defects found in this process?

(5 marks)

Total 25 Marks

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Q3. Material Cutting and Joining Processes

a) In the manufacturing of metal products, joining and cutting are two fundamental processes that each play a critical role. Could you explain the main differences between metal joining and metal cutting, and provide five examples of each?

(10 marks)

b) Welding processes can be classified into different categories based on various factors such as the type of heat source, the type of filler material, the welding position, and the type of shielding gas used. Briefly describe the metal welding process? Provide five common ways of welding processes with brief description.

(10 marks)

c) In machining, creating precise holes in materials involves several processes to ensure accuracy and smoothness. Can you describe the sequence of operations involved in drilling, boring, and reaming to achieve a finished hole?

(5 marks)

Total 25 Marks

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Section 2: Materials and Mechanics

Q4. Materials Characterisation and Testing

a) Describe with diagram the Body centred cubic (BBC) and Face centred cubic (FCC) crystal structure. Give TWO examples of substances for each.

(7 marks)

b) Outline the main differences between thermoplastics and thermosets with reference to typical applications. Give at least THREE examples of each.

(6 marks)

c) What do you understand by the term Material Characterisation? State FIVE application of Material characterisation.

(6 marks)

d) Describe the TWO classifications of material based on scale of testing and THREE common instruments for each one.

(6 marks]

Total 25 Marks

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Q5. Advanced Materials

a) Draw the Iron-carbon diagram showing the following features.
   I. Temperatures
   II. % Carbon
   III. Austenite
   IV. Liquid+ Austenite
   V. Ferrite
   VI. Ferrite + Cementite

(10 marks)

b) Describe THREE advantages of the Iron-carbon phase diagram.

(3 marks)

c) How does the Iron-Carbon Phase Diagram help predict the mechanical properties?

(4 marks)

d) Martensite is the key phase for strengthening steels. Briefly discuss the structure, properties of martensite; Discuss the factors that can be used to modify the strength of steels.

(8 marks)

Total 25 Marks

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Q6. Mechanics

a) State TWO objectives and FIVE methods of carrying out Material characteristisation.

(7 marks)

b) Define composite materials and explain their advantages in engineering applications (at least FOUR applications).

(5 marks)

c) Describe THREE reinforcement constituents in composite materials.

(3 marks)

d) Just recently a group of aspiring material engineers were asked to examine the mechanical property of a certain material. The material was a bar of length 250mm, width of 35mm and thickness of 5mm. This material was simply supported at both ends and subjected to different loading conditions as shown in the table below. If the different loading gave the corresponding deflections as shown in the Table 1 below. Calculate the Young's modulus of this material.

Table 1: Mass, Force and Deflection information of material

Mass (kg)	F (N)	Deflection(δ) (mm)
100		0.411
300		0.543
500		0.642
700		0.721
900		0.813

(10 marks)

Total 25 Marks

END OF QUESTIONS

FORMULA SHEET FOLLOWS ON NEXT PAGE

PLEASE TURN THE PAGE…

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FORMULA SHEET

Second moment of area of a rectangular beam,

$$I = \frac{bd^3}{12}$$

where, b is width and d is thickness.

Maximum deflection,

$$\delta max = \frac{FL^3}{48EI}$$

where, F is force, L is length, and E is Young's Modulus, again,

$$F = mg$$

where, m is mass and g is gravity.

END OF FORMULA SHEET

END OF PAPER

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