Examination Period 3: 2018/19

MODULE TITLE

Manufacturing and Manufacturing Systems Technology

LEVEL

Five

TIME ALLOWED

Two hours

Instructions to students:

• Enter your student number **not** your name on all answer books.
• Answer **all** questions.
• Where a question has more than one part the division of marks is clearly stated.
• Begin each question on a separate page; label each page clearly with the number of the question you are answering.
• The use of a calculator **is** permitted.
• Graph paper can be located at the back of each answer book.
• Formulae is provided at the back of this exam paper.

No. of Pages 4

No. of Questions 5
Answer all questions.

Question 1

a. Name three main different engineering material types and two of the technological and commercial importance of each one. (9 marks)

b. What are Ferrous Metals? (2 marks)

c. Explain the following Manufacturing process:
   i. solidification processes (3 marks)
   ii. coating and Thin film deposition processes (3 marks)
   iii. brazing and soldering (3 marks)

Total: 20 marks

Question 2

A cylindrical riser must be designed for a sand-casting mold. The casting itself is a steel rectangular plate with dimensions 7.5 cm* 12.5 cm* 2.0 cm. Previous observations have indicated that the total solidification time (TTS) for this casting is 1.6 min. The cylinder for the riser will have a diameter-to-height ratio of 1.0; Determine the dimensions of the riser so that its TTS will be 2.0 min.

Total: 20 marks
Question 3

For a litter-bin manufacturer, a process is needed which will produce the ‘bin’ or material containing part. It can be made from a polymer or a metal.

a. Describe with diagrams a suitable manufacturing process. (10 marks)

b. Using this process:
   - One bin container is made every five minutes.
   - The process has two operatives. Their wages are £15 per hour.
   - The material costs for this part is £5 per unit.
   - The fixed costs of this press are £2,500 per batch.
   - A new machine is recommended by the production engineer, which will have fixed costs of £8,000 per batch. It needs only one operative.
   - The machine produces one ‘body’ every two minutes.
   - The material costs stay unchanged.

Sketch a break even graph making a comparison for these two processes. (5 marks)

c. A new less expensive tool is proposed which will drop the fixed cost to £4,000 from start for process number two. However, the material it is made from is not as resilient as the original press tool. It will need a partial refurbishment every 5000 parts, which has a fixed cost of £2000.

Explain the advantages and disadvantages of using tooling/machinery with a shorter life expectancy, but lower capital cost.

Draw the new graph with this change. (5 marks)

Total: 20 marks

Question 4

a. An extruder barrel has a diameter \( D = 75 \) mm. The screw rotates at \( N = 1 \) rev/s. Channel depth \( d_c = 6.0 \) mm and flight angle \( A = 20^\circ \). Head pressure at the end of the barrel \( p = 7.0*10^6\)Pa, length of the barrel \( L=1.9\)m, and viscosity of the polymer melt is assumed to be \( h = 100 \) Pa-s. Determine the volume flow rate of the plastic in the barrel \( Q_x \). (10 marks)

b. Determine what is the maximum head pressure \( p_{\text{max}} \) would have to be to cause no flow in the extruder. (10 marks)

Total: 20 marks
Question 5

Orthodontic braces have been available to straighten teeth for more than 50 years. The braces involve metal, ceramic, or plastic brackets that are bonded adhesively to teeth with fixtures for attachment to a wire, which then forces compliance on the teeth and straightens them to the desired shape within a few years. Conventional orthodontic braces are a well-known and successful technique for ensuring long term dental health. However, there are several drawbacks to conventional braces, including the facts that:

a. they are aesthetically unappealing  
b. the sharp wires and brackets can be painful  
c. they trap food leading to premature tooth decay  
d. brushing and flossing teeth are far more difficult and less effective with braces in place  
e. certain foods must be avoided because they will damage the braces

The Invisalign system, made by Align Technology, which consists of a series of aligners, each of which the person wears for approximately two weeks. Explain the manufacturing sequence for Invisalign orthodontic aligners and how this new improvement overcome the problems a, b, c, d and e.

Total: 20 marks

Formulae

Flow rate of polymer melt in the extruder:

\[ Q_s = Q_d - Q_b \]
\[ Q_s = 0.5 \pi^2 D^2 N d_c \sin A \cos A - \frac{p \pi D d_c^3 \sin^2 A}{12 \eta L} \]

Chvorinov’s rule:

\[ T_{TS} = C_m \left( \frac{V}{A} \right)^n \]