Unit 7: Machining and Processing of Engineering Materials

Unit code A/615/1481
Unit level 4
Credit value 15

Introduction
Practical articles that we see and use every day such as automobiles, aircraft, trains, and even the cans we use to store our food, came from the ideas and visions of engineers and designers. The production of these articles is based on well-established production processes, machines and materials.

The aim of this unit is to introduce students to the application of a variety of material forming processes involved in the production of components and articles for everyday use. Among the topics included in this unit are: conventional machining, shaping and moulding processes used in the production of components, machine tooling, jigs and fixtures required to support the manufacture of components, using metallic and non-metallic materials such as polymers and composites.

On successful completion of this unit students will be able to describe moulding, shaping and forging manufacturing processes, explain the importance of material selection, and summarise the impact machining processes have on the physical properties of a component.

Learning Outcomes
By the end of this unit students will be able to:

1. Explore the conventional machining and forming processes and their application in the production of engineered components.
2. Explain how component materials, metals and non-metals, affect the selection of the most appropriate machining or forming process.
3. Identify the most appropriate machine tooling, jigs and fixtures to support the production of an engineered component.
4. Identify the most appropriate moulding and shaping process used to produce a range of metal and non-metal engineered components.
Essential Content

LO1  **Explore the conventional machining and forming processes and their application in the production of engineered components**

*Conventional processes:*
- Material removal machining processes including: conventional manual processes, CNC machining and erosion machining technologies
- Selection of machining processes to generate geometrical forms: flat and cylindrical geometry
- Impact of material removal rate on surface finish and texture and speed of production
- Consideration of the effect of production volume (prototypes, batch, and high volume) on the selection of the most appropriate process, tooling and resource commitment
- Safe working practices when operating machining and process forming equipment

LO2  **Explain how component materials, metals and non-metals, affect the selection of the most appropriate machining or forming process**

*Material choice and machine process:*
- Impact of material types on the choice of machining process including: round, square and hexagonal bar, tube, plate, section and pre-cast
- Machining characteristics when using polymers, composites, non-ferrous and ferrous metals and exotic materials
- How the mechanical properties of the component material can be affected by the machining process
- Effect of lubricants, coolants and cutting fluids on tooling, production speed, and quality of finish

LO3  **Identify the most appropriate machine tooling, jigs and fixtures to support the production of an engineered component**

*Awareness of the range of cutting tools:*
- Factors that prolong tool life, increased material removal rate and improved surface finish
- Properties for cutting tool materials
- Cause and effect of premature and catastrophic tool failure, preventative measures to promote tool life
Cutting forces and the mechanics of chip formation:
Factors that affect cutting speeds and feeds, calculating cutting speeds and feeds
Relationship between cutting speed and tool life, economics of metal removal
Range of tooling jigs and fixtures including mechanical, magnetic, hydraulic and pneumatic
Work-holding: six degrees of freedom

LO4 Identify the most appropriate moulding and shaping process used to produce a range of metal and non-metal engineered components

Moulding and shaping processes:
Range of metal and ceramic powder moulding and shaping processes
Casting, powder metallurgy and sintering
Range of plastic moulding and shaping processes: blow, compression, extrusion, injection, laminating, reaction injection, matrix, rotational, spin casting, transfer and vacuum forming

Range, benefits and limitations of various shaping processes:
Extrusion, forging, rolling, hot and cold presswork

Range of casting processes:
Sand, permanent mould, investment, lost foam, die, centrifugal, glass and slip casting
### Learning Outcomes and Assessment Criteria

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<thead>
<tr>
<th>Pass</th>
<th>Merit</th>
<th>Distinction</th>
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<tr>
<td><strong>LO1</strong> Explore the conventional machining and forming processes and their application in the production of engineered components</td>
<td><strong>P1</strong> Describe the most appropriate machining process to manufacture a selected product</td>
<td><strong>D1</strong> Determine the benefits and limitations of components manufactured using conventional machining and moulding processes</td>
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<td><strong>P2</strong> Explain why a specific machining process would be used to manufacture a selected component</td>
<td><strong>M1</strong> Examine the characteristics of conventional machining processes, plastic moulding processes and powder metallurgy</td>
<td><strong>D2</strong> Review the structure and mechanical properties of a given engineered aluminium alloy component, manufactured using the die casting process and conventional material removal machining processes</td>
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<td><strong>LO2</strong> Explain how component materials, metals and non-metals, affect the selection of the most appropriate machining or forming process</td>
<td><strong>P3</strong> Describe how the manufacturing process can affect the structure and properties of the parent material</td>
<td><strong>D3</strong> Examine the relationship between cutting speed and tool life on the economics of metal removal</td>
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<td><strong>P4</strong> Describe the effect lubricants, coolants and cutting fluids have on tooling, production speed, and quality of finish</td>
<td><strong>M2</strong> Detail the characteristics of cutting tool geometries</td>
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<td><strong>LO3</strong> Identify the most appropriate machine tooling, jigs and fixtures to support the production of an engineered component</td>
<td><strong>M3</strong> Explain why different tool geometries are required for polymer, composite and carbon steel materials</td>
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<td><strong>P5</strong> Review the parameters that determine the appropriate tooling for the production of a given engineered component</td>
<td><strong>M4</strong> Explain the properties and applications of ceramics tools and cubic boron nitride tools</td>
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<td><strong>P6</strong> Describe the six modes of cutting tool failure</td>
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<td><strong>LO4</strong> Identify the most appropriate moulding and shaping process used to produce a range of metal and non-metal engineered components</td>
<td><strong>D4</strong> Investigate how the composition and structure of metal alloys, polymers and polymer matrix composites are affected by the material machining or forming process</td>
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<td><strong>P7</strong> Explain which material characteristics determine the choice of plastic moulding process</td>
<td><strong>M5</strong> Explain each of the stages of the ceramic powder moulding process and comment on the benefits associated with this manufacturing process</td>
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<td><strong>P8</strong> Describe the benefits and limitations of products manufactured by the sintering process</td>
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Recommended Resources

Textbooks

Journals

Websites
http://www.machinery.co.uk/ Machinery
(General Reference)
http://www.materialsforengineering.co.uk/ Engineering Materials
Online Magazine
(E-Magazine)

Links
This unit links to the following related units:
Unit 9: Materials, Properties and Testing
Unit 10: Mechanical Workshop Practices