## Summer Examinations 2015

**ENG200215N**

<table>
<thead>
<tr>
<th>Module Title</th>
<th>Applications of Engineering</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level</td>
<td>Five</td>
</tr>
<tr>
<td>Time Allowed</td>
<td>Two hours</td>
</tr>
</tbody>
</table>

### Instructions to students:

- Enter your student number **not** your name on all answer books.
- Answer **three** out of **four** questions.
- All questions are equally weighted. Where a question has more than one part the division of marks is stated.
- Begin each answer on a separate page; label each page clearly with the number of the question you are answering.
- The use of a non-programmable scientific calculator is permitted.
- Graph paper and a formula booklet are provided.
- Students are permitted to remove this examination paper at the end of the examination.

<table>
<thead>
<tr>
<th>No. of Pages</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Questions</td>
<td>4</td>
</tr>
</tbody>
</table>
Answer **three** out of **four** questions.

**Question 1**

For a public 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.  

(12 marks)

b. Using this process:

- One bin container is made every 5 minutes.
- The process has 2 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 2 minutes.
- The material costs stay unchanged.

Sketch a break even graph making a comparison for these two processes.  

(7 marks)

c. A new less expensive tool is proposed which will drop the fixed cost to £4,000 from start for process number 2. 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.  

(6 marks)

**Total: 25 marks**
Question 2

Ensuring effective health and safety procedures are in place is a key legal obligation for all UK based engineering companies. Failures in health and safety can have very significant impacts upon both employees and the companies.

Using an example you are familiar with, identify a situation where health and safety practices failed and address the following:

a. Identify four examples of failures in health and safety procedures and explain the impact each failure had on the incident.  
   (10 marks)

b. Evaluate the impacts health and safety failures have upon the company and those involved in the incident.  
   (5 marks)

c. Identify and discuss any changes that were implemented following the incident.  
   (5 marks)

d. Explain the requirements of a typical risk assessment, describing how overall risk is arrived at.  
   (5 marks)

Total: 25 marks
Question 3

a. Under what physical conditions can equation (i) below be simplified into equation (ii).

\[ \sigma_c = \frac{K_{lc}}{Y \sqrt{\pi d_{max}}} \]

(ii)

\[ \left( \sigma_c \sqrt{d_{max}} \right)_A = \left( \sigma_c \sqrt{d_{max}} \right)_B \]

(5 marks)

b. Draw a diagram corrosion cell where copper is one electrode and steel is the other electrode. (Label and name the important features that allow the cell to operate and state what part each plays).

Give the general anodic reaction formula for the appropriate metal and explain which direction the electrons are flowing. What happens if one component of a corrosion cell is removed? If the copper and steel are coupled electrically what happens to the corrosion rate of the dissolving metal in comparison to the non-coupled state, if anything?

(10 marks)

c. Suppose that a wing component on an aircraft is fabricated from an aluminium alloy.

It has been determined that fracture results at a stress of 465 MPa when the maximum internal crack length is 1.5 mm.

For this same component and alloy, compute the stress level at which fracture will occur for a critical internal crack length of 4.0 mm.

Show the appropriate formula from “Part A” of this question and all working.

(10 marks)

Total: 25 marks
Question 4

a. Explain why an Aluminium ring placed over a core of an induction coil jumps high in the air and falls back again when the coil is connected to a DC source.

(15 marks)

b. What happens if the coil is disconnected and why?

(10 marks)

Total: 25 marks