Please answer any THREE Questions from the FIVE questions provided

This is a CLOSED book examination

The use of electronic calculators is permitted provided they are not programmable and do not store text.
1. **Visualization Critic**

The four figures below come from the Guardian newspaper. For each of the four charts describe their good and bad features, and if appropriate a better way to present the data.

(Figure 1: 5 marks, Figure 2: 7 marks, Figure 3: 4 marks, Figure 4: 4 marks)

(Question 1 continues on the following page)
(Question 1 continues from the previous page)

How the two huge markets compare, % of spending

**LCD TVs**
- **China**: 12.0%
- **Japan**: 20.9%

**Digital still cameras**
- **China**: 5.2%
- **Japan**: 9.3%

**Laptops**
- **China**: 5.7%
- **Japan**: 11.7%

**Mobile & smart phones**
- **China**: 35.9%
- **Japan**: 11.5%

SOURCE: GFK
2. **The Human Visual System in Visualization**

a) Briefly explain the following terms as they relate to the visual spectrum. (5x2 Marks)

i) The Electromagnetic Spectrum and the range in terms of wavelength of the visible part.

ii) The Dominant Wavelength within a specific spectrum.

iii) The CIE Standard Illuminant C.

iv) Protanopia Confusion Lines.

v) Location and function of Horizontal Cells within the Human Visual System.

b) The optical effect of Mach banding occurs when regions of different intensity are adjacent to each other as seen in the following example.

![Image of Mach banding](image)

Explain what is happening at the border both with respect to the illusion perceived and to the possible operations that makes this happen within the early part of the human visual system. Sketch a filter of the perceived intensity, as a viewer may see it, covering one of the boundaries. (3x2 Marks)

c) A researcher wants to create a smooth graduated surface for a particular visualization purpose. Describe some rules that the researcher needs to follow to create one of these within his visualization. (2 Marks)

d) A second researcher actually wants to highlight edges; as the display device being used does not have a large enough dynamic range for the high dynamic range image that is required to be shown. Explain how a filter may be created to enhance and create fake edges. (2 Marks)
3. **Reference Model**

a) Why are reference models important? (2 marks)

b) With the aid of the diagram below and your own additional diagrams describe the Haber-McNabb reference model. (12 marks)

c) Describe postprocessing, linear interaction and computational steering and how they relate to the diagram. (6 marks)
4. **Parameterisation of x-y data**

<table>
<thead>
<tr>
<th>X</th>
<th>Y</th>
</tr>
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<tbody>
<tr>
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<tr>
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<tr>
<td>1</td>
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a) Given the x-y data in the table above sketch x vs y. Using a parameterisation of 
t_i = i sketch graphs of x vs t and y vs t.  

b) With the aid of these graphs explain why when given a set of (x,y) data points to 
interpolate (or approximate), we turn it into two interpolation (or approximation) 
problems, that of x vs t and y vs t.  

c) Give two disadvantages of having two interpolation schemes instead of one. 

d) Give two advantages and one disadvantage of this parameterisation scheme. 

e) Describe the 
   i) Chord length, and 
   ii) Centripetal 

ways of assigning a parameter value to each data point and highlight their good 
and bad aspects. 

5. **Volume Visualization**

a) In volumetric medical datasets one of the issues is assigning data ranges to 
   correspond to air, fat, soft tissue, bone, etc. What is the main problem with this 
   and how is it solved? Use diagrams to show the nature of such sampled data 
   and its representation of physical materials and features such as bone etc. 

b) The algorithms for volume visualization require classification of the volume data. 
   Discuss the main approaches to colour and opacity classification of volume 
   data, detailing the different techniques and their benefits. You are encouraged to 
   use diagrams to illustrate examples of the mappings to colour and opacity. 

c) How can the use of gradients be added to the classification? Use diagrams to 
   aid your answer. 

d) What are the main reasons for using opacity, colour and gradient mappings in 
   volume visualization and their benefits? 

END OF EXAMINATION