Sample paper for COMP27112 online exam from AY16

From AY16 the COMP27112 exam will be online. The format of the paper is as follows:

Part A comprises 20 compulsory MCQ questions. Note that there is no negative marking. For example, if you answer 14 out of the 20 questions correctly, do not answer 2 at all, and get the other 4 wrong, you get 14 marks. There are no trick questions or anything unfair.

Part B comprises a set of compulsory short essay-type questions. There will be between 14-20 questions here, adding up to a total of 40 marks. Because the exam is online you will not be able to draw diagrams as part of your answers (and paper answer books will not be available).

Revision. Before AY16, COMP27112 was a paper exam, and past papers are available – see the course Blackboard page for the link. The style of the essay-type questions has not changed, except in the online exam the questions are in smaller chunks, which allows more coverage of the syllabus.

Sample online paper Part A. Answer all questions.

The following are examples of the types of MCQ questions you should expect to find in the compulsory Part A of the COMP27112 exam paper. Here we provide 6 examples. There will be 20 questions in the exam.

1. Median smoothing is used to
a. reduce the apparent size of objects
b. reduce the range of colours in an image
c. suppress noise in an image
d. make objects appear brighter

2. Convolution of an image and a template is used to
a. measure the similarity between image patches and the template
b. change the contrast in the image
c. differentiate between foreground and background
d. suppress unusual structures in the image

3. Stretching the grey scale in a black and white image will
a. make foreground objects look darker
b. make background objects look darker
c. suppress edges in the image
d. increase the amount of contrast in the image

4. In order to scan-convert a triangle, we must always
a. clear the frame-buffer first
b. know the coordinates of the triangle's vertices

c. compute the area of the triangle
d. know the coordinates of all other triangles in the scene

5. The Z-buffer is a technique for
a. efficiently solving the hidden-surface problem
b. reducing the noise in images
c. maximising the colour range in an image
d. eliminating shadows in renderings

6. Homogeneous coordinates are used in Computer Graphics to
a. reduce floating-point number rounding errors
b. improve the signal-to-noise ratio in an image
c. compute the inverses of singular transformations
d. provide a consistent representation for different types of transformations

Answers:
1c, 2a, 3d, 4b, 5a ,6d

Sample online paper Part B. Answer all questions.

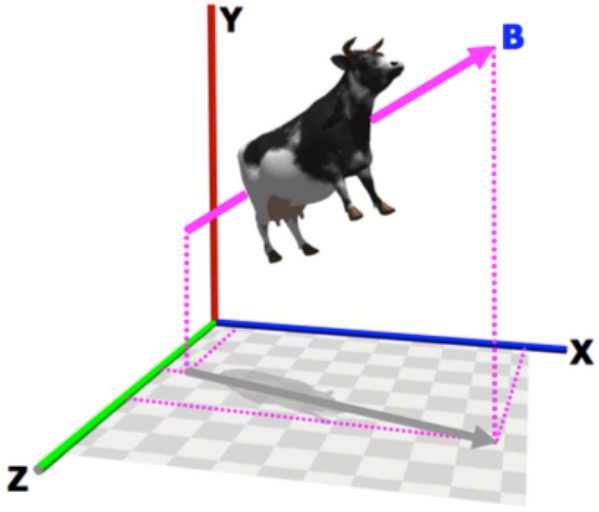
The following are examples of the types of short essay-type questions you should expect to find in the compulsory Part B of the COMP27112 exam paper. Here we provide 19 examples. There will be between 14-20 questions in the exam, adding up to a total of 40 marks. Because the exam is online you will not be able to draw diagrams as part of your answers (and paper answer books will not be available).

1. Explain the distinction between the activities of "modelling" and "rendering", in Computer Graphics. (2 marks)

2. What is a limitation of using a 3 × 3 matrix to represent 3D transformations? (1 mark)

3. In 3D computer graphics, what is the function of "the camera"? (1 mark)

4. Look at the diagram below, and explain how to derive a single transformation matrix which rotates the cow by angle theta with respect to the vector *B*. *B* does not pass through the origin, and is not embedded in the *XY*, *XZ* or *YZ* planes. (4 marks)



5. In viewing, what is meant by the near and far clip planes? (2 marks)

6. Explain how you would apply the local illumination model to a triangle mesh, such that it is smoothly shaded, and correctly takes into account specular reflection. (3 marks)

7. What is a normalized vector? Give an example of its use in computer graphics (1 mark)

8. What is the purpose of the OpenGL "matrix stack"? Illustrate your answer with a practical example of its use. (2 marks)

9. What transformation does this matrix represent? (1 mark)

$$\begin{bmatrix} 0 & 0 & 0 & p \\ 0 & b & 0 & q \\ 0 & 0 & c & r \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

10. Why do textures usually need to be filtered during rendering? Describe the bilinear interpolation filter (2 marks).

11. What is the histogram of an image? (1 mark)

12. An image might be non-uniformly illuminated. What is the consequence of this for thresholding? How could this be corrected? (2 marks)

13. Explain the process of convolution as it is used in image processing. Give a simple interpretation of the meaning of the results (4 marks).

14. What principles would you follow to design the kernel to be used to recognize cars from a rear view? What would your kernel look like? (2 marks)

15. You've been asked to implement software to identify flooded areas from low-level aerial images, such as the one below. How will you do this (4 marks)? How will you validate your results (1 mark)?

16. Colour data is represented by using three primitives. What are they and why were they chosen (2 marks)?

17. What data would you use to identify coloured objects in a range of light intensities (1 mark)?

18. Your face could be used as a biometric identifier. What does this mean? What features of your face would be useful in this context? What image processing techniques would you use to identify them? (3 marks)

[end of questions]

Sample answers and mark breakdown

Note. These are sample answers only; other answers may be acceptable at the discretion of the examiner.

1. Modelling is about constructing something to represent an idea; in CG the model is usually geometrical [1 mark]; rendering is the process of creating a visual representation of the model [1 mark].

2. A 3x3 matrix cannot represent a 3D translation transformation [1 mark]

3. The camera is shorthand for the viewing process; it transforms coordinates to simulate the operation of a real camera which creates 2D image of a 3D world [1 mark]

4. The principle is to break the hard problem into a sequence of simple problems [1/2 mark]; first translate B so that one end is at the origin

(transformation T1) [1/2 mark];. Call the new vector B1; then rotate B1 until it lies in the XY plane (transformation T2) [1/2 mark], call this B2; then rotate B2 until it is coincident with the X axis (transformation T3) [1/2 mark], call this B3. Now rotate about B3 by theta (transformation T4) [1/2 mark]; now undo [1/2 mark] each of the previous transformations T3, T2, T1 in turn [1/2 mark]. The resultant composite transformation $T1^{-1}\ T2^{-1}\ T3^{-1}\ T4\ T3\ T2\ T1$ is the desired transformation [1/2 mark].

5. The near and far clip planes set the forward and rear boundaries of the view volume [1 mark]; geometry is clipped at these boundaries [1 mark].

6. We deal with each triangle T in the mesh in the same way. First we need to compute the average normal vectors at each vertex V of T [1/2 mark] by averaging the surface normal of the triangles which also share V [1/2 mark]; then we process each scanline for the triangle [1/2 mark]; for the part of scanline S which covers T, we compute an averaged normal at the pixels at the start (P) and end (Q) of the scanline segment [1/2 mark] by averaging from the respective vertices; we then step along the scanline from P to Q, and apply the full local illumination model for each pixel [1/2 mark], smoothly interpolating the normal for each pixel between P and Q [1/2 mark].

7. A vector with length one [1/2 mark]; common use: surface normal, to give the direction a triangle is facing, needed during rendering [1/2 mark].

8. The matrix stack is for saving the current transformation T(for example, the modelview matrix); the user can then modify T, and then reset T to the saved value [1/2 mark]; example of use (any sensible idea accepted): drawing an overlay on the screen for (say) a framerate counter [1/2 mark]. We stack the current view, replace it with the overlay view, then unstack and restore the usual view.

9. It's a scale by (A,B,C) [1/2 mark]; and a translation by (P,Q,R) [1/2 mark].

10. Usually texel resolution does not match pixel resolution, therefore we need to apply a filter to resolve the mis-match [1 mark]; the bilinear interpolation filter is used when the texel resolution is less than the pixel resolution [1/2 mark];; each pixel receives a colour averaged from adjacent texels [1/2 mark].

11. Histogram represents frequency of occurrence of each grey or colour value [1 mark].

12. Consequence is the threshold is correct in some regions, too high or too low in others [1 mark]. Correction is by adjusting the threshold throughout the image [1 mark].

13. Convolution requires a template. This is placed at all locations on the image, overlapping image/template values are multiplied and added to give a result. [2 marks] Special consideration in areas where the template extends beyond the image boundary: either ignore these locations or pad the image. [1 mark]. The result measures the resemblance of the template with that portion of the image [1 mark].

14. Always looking for invariants – properties of the object that are the same for all instances of the object [1 mark]. In this case it could be the shadow under the car [1 mark].

15. Task could be achieved by thresholding – would expect the answer to include a discussion of how to find a threshold. Or by using texture – you'd expect waterlogged regions to look different on a small scale to dry areas. So if you can measure local properties of an image you have a way of classifying, local properties could include variance [3 marks]. The classification image should be cleaned up to reduce false positives/negatives – median filter [1 mark]. Validation is by comparing to manually labelled images [1 mark]

16. Primitives are *called* RGB but they're not really red, green, blue [1 mark]. They are matched to the response of the human visual system to longer, medium and shorter wavelength illuminants [1 mark]

17. Chromaticities – either HS from HSV or normalized red and normalized green [1 mark]

18. Identifier – something that lets us recognize the owner; biometric – a property of the owner's physiology or anatomy [1 mark]. Good features: things that are variable between people but constant for an individual, e.g. relative locations of the eyes, nostrils, mouth; but NOT e.g. colouration, hair [1 mark]. Image processing: colour finding to find a face, eyes could be found by looking for circular objects, nostrils are found by looking for dark blobs, etc. Almost any sensible answer will be given the mark [1 mark]

[end]