Version TDW/3

EGT3
ENGINEERING TRIPOS PART IIB

Tuesday 21 April 2015 9.30 to 11

Module 4B20

DISPLAY TECHNOLOGY

Answer not more than ***three*** *questions.*

All questions carry the same number of marks.

The ***approximate*** *percentage of marks allocated to each part of a question is indicated in the right margin.*

Write your candidate number ***not*** *your name on the cover sheet.*

STATIONERY REQUIREMENTS
Single-sided script paper

SPECIAL REQUIREMENTS TO BE SUPPLIED FOR THIS EXAM
CUED approved calculator allowed
Engineering Data Book

10 minutes reading time is allowed for this paper

You may not start to read the questions printed on the subsequent pages of this question paper until instructed to do so.

1 (a) In the context of a display system define the terms *refractive index* and *optical anisotropy*. Give an example of three different optically anisotropic materials. What other parameter is required in order to make a material a suitable candidate for use in a display? [20%]

(b) Explain with the aid of a simple diagram, how the parameters discussed in part (a) can be used to create a positive focal length paraxial lens. What parameter is used to control the focal length of this lens? [35%]

(c) The property of refractive index is often limited by dispersion. How does dispersion arise in optically isotropic display materials? Sketch a typical dispersion curve that might be found for a material such as borosilicate glass. How might dispersion be used to measure the colour components of white light? [30%]

(d) A singlet lens has been designed for use in a data projector using borosilicate glass. Why will this lens never be able to perform well enough for this application? How might the property of dispersion be used to solve this limitation? [15%]

2 (a) Explain the physical mechanisms underlying light controlling and light generating displays. Give three examples of display technologies that fit into each of these categories. [20%]

(b) What are the benefits and tradeoffs of passive matrix displays versus active matrix displays. Elaborate on the backplane requirements of Active-Matrix Organic Light-Emitting Diode (AMOLED) displays that make them different from their liquid crystal counterparts? [30%]

(c) Identify the four basic Thin Film Transistor (TFT) backplane technologies that are of current interest for use in AMOLED displays. Tabulate their key performance attributes in terms of mobility, temporal stability, spatial uniformity, scalability, and cost. [30%]

(d) With the aid of architectural schematics briefly describe the benefits and trade-offs of bottom emission versus top emission AMOLED displays. [20%]

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3 (a) Explain what is meant by the term *dielectric anisotropy* when considering liquid crystal materials. List three fundamental properties of a molecule that will govern its dielectric anisotropy. How does the sign of the dielectric anisotropy effect its use in liquid crystal displays? [30%]

(b) Sketch the cell structure of a Vertically Aligned Nematic (VAN) display. Identify the orientation of the liquid crystal in the two extreme switched states. What are the key design parameters of the liquid crystal material for use in a VAN display? [30%]

(c) Another popular display mode used in liquid crystal displays is the In-Plane Switching (IPS) mode. Show how this mode works and is implemented in a modern display. Discuss how this mode differs from a VAN display. [40%]

(cont.

4 (a) A three dimensional display can be created using the *autostereoscopic principle*. Explain how this principle works and give two examples of glasses based three dimensional projection systems that use it. [30%]

(b) The Real-D three dimensional projection system is designed to work with existing two dimensional data projectors by adding a single pixel shutter to the projection optics. What principle is this shutter using to create an autostereoscopic effect and what is the main drawback of this technique? What other components are required to make this projection effect work? [30%]

(c) What sort of technology could be used for the single pixel shutter used in the Real-D system? How do the design tolerances of the shutter dictate its performance? If a full colour high definition (1080P) three dimensional movie running at 120 frames per second is to be viewed, what would the shutter speed have to be? Is this realistic? [30%]

(d) Does the Real-D three dimensional projection system place any limitations on the type of data projector used? Explain your answer. [10%]

END OF PAPER

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