

**Q1.(a)** An endoscope uses **coherent** and **non-coherent** fibre bundles.

(i) State the use of the **coherent** bundle and describe its arrangement of fibres.

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**(2)**

(ii) State the use of the **non-coherent** bundle and describe its arrangement of fibres.

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**(2)**

(b) Each fibre has a core surrounded by cladding.  
Calculate the critical angle at the core-cladding interface.

refractive index of core = 1.52  
refractive index of cladding = 1.49

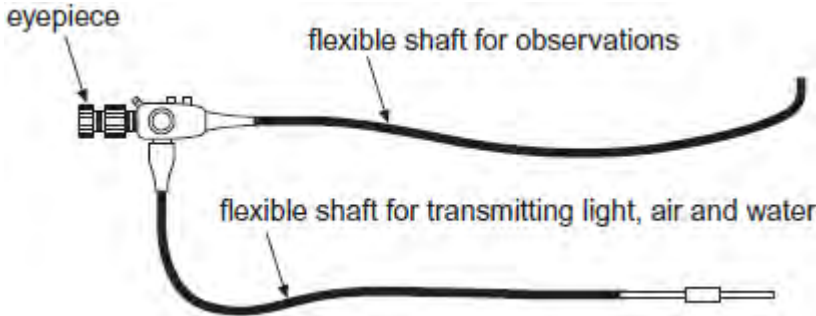
critical angle = ..... degree

**(1)**

**(Total 5 marks)**

**Q2.**Figure 1 shows an endoscope. Some of the optical fibres in the endoscope are arranged in coherent bundles and others are in incoherent bundles. The eyepiece of the endoscope may be replaced with a digital camera.

**Figure 1**



(a) Explain the difference between **coherent bundles** and **incoherent bundles** of optical fibres and explain which are appropriate for the different parts of the endoscope.

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(3)

(b) Explain how a digital camera can store the image produced by the endoscope.

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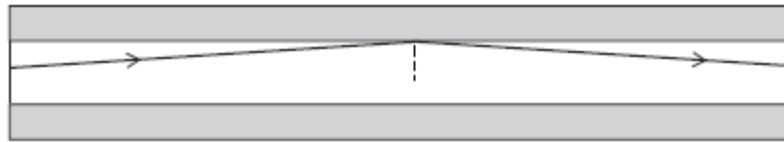
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(3)

- (c) **Figure 2** shows a ray of light travelling through an individual fibre consisting of cladding and a core. One part has a refractive index of 1.485 and the other has a refractive index of 1.511.

**Figure 2**



- (i) State which part of the fibre has the higher refractive index **and** explain why.

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(1)

- (ii) Calculate the critical angle for this fibre.

critical angle ..... degrees

(1)

- (iii) The endoscope image quality may be reduced by crosstalk.

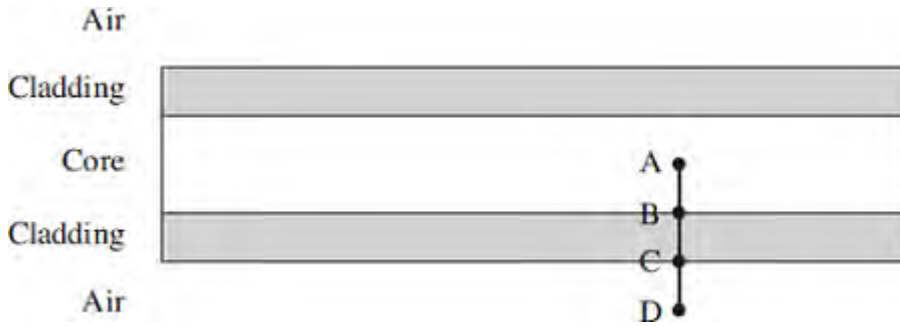
Explain what is meant by **crosstalk** and how it limits the usefulness of the endoscope.

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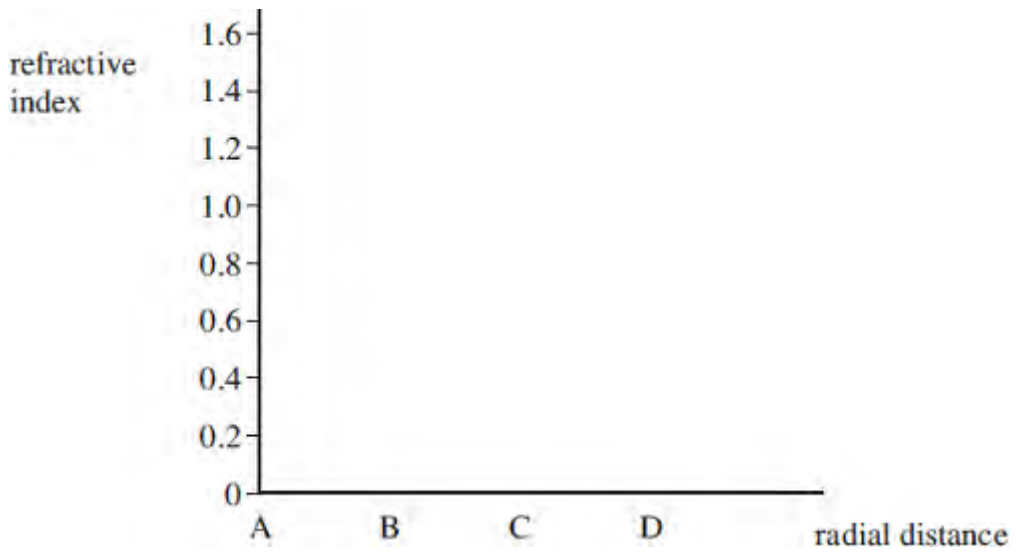
(2)

(Total 10 marks)

**Q3.** (a) The figure below shows the cross-section through a clad optical fibre which has a core of refractive index 1.50.



Complete the graph below to show how the refractive index changes with the radial distance along the line ABCD in the figure above.



(3)

(b) In the optical system of a flexible endoscope there are two types of fibre bundles, coherent and non-coherent. Explain the purpose of each of these two types of bundle.

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(2)  
(Total 5 marks)

**Q4.** An endoscope contains two bundles of optical fibres.

- (a) Name the two bundles. For each bundle state clearly the arrangement of the fibres and explain its purpose in the operation of the endoscope.

Bundle 1 .....

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Bundle 2 .....

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(4)

- (b) Each fibre has a core surrounded by cladding. Calculate the critical angle at the core – cladding interface of a fibre.

refractive index of core = 1.60

refractive index of cladding = 1.55

answer = ..... degree

(1)

(Total 5 marks)

**Q5.** (a) State and explain **two** physical properties of the light produced by a laser which makes it different from the light produced by a filament lamp.

property 1.....

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property 2.....

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(3)

(b) An endoscope may use light from a filament lamp and light from a laser.

State

(i) the use of the light from a filament lamp,

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(ii) a use of the light from a laser.

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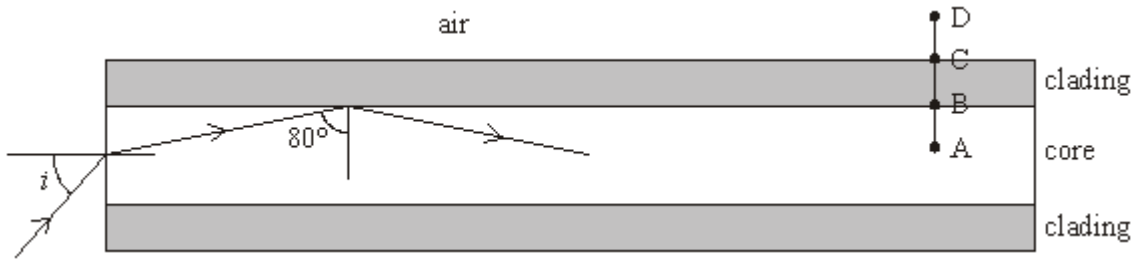
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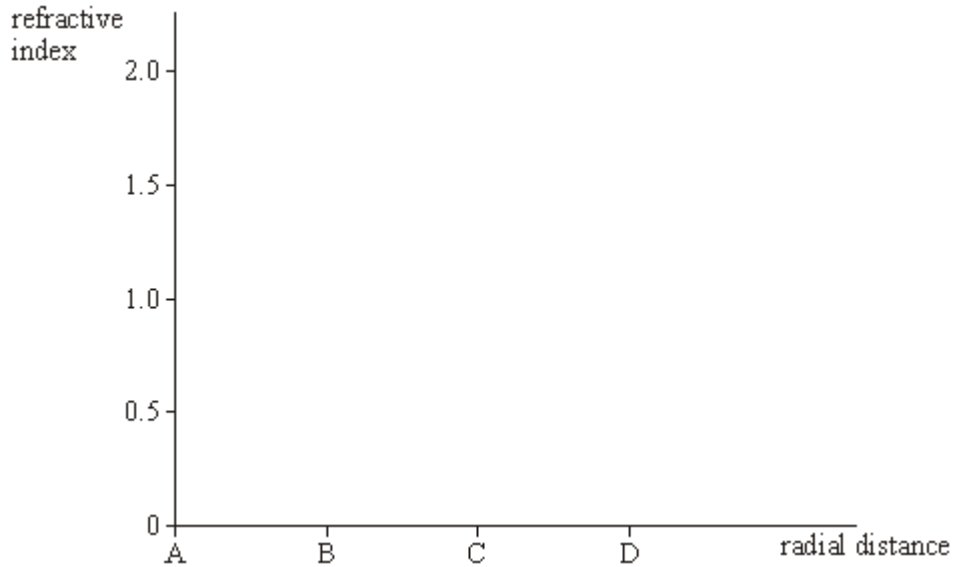
(2)

(c) The figure below shows a cross-section through an optical fibre used in an

endoscope. The core is made from glass of refractive index 1.5.



- (i) Complete the graph below to show how the refractive index changes with radial distance along the line ABCD in the figure above.



- (ii) Calculate the value of the angle of incidence,  $i$ , shown in the figure above.

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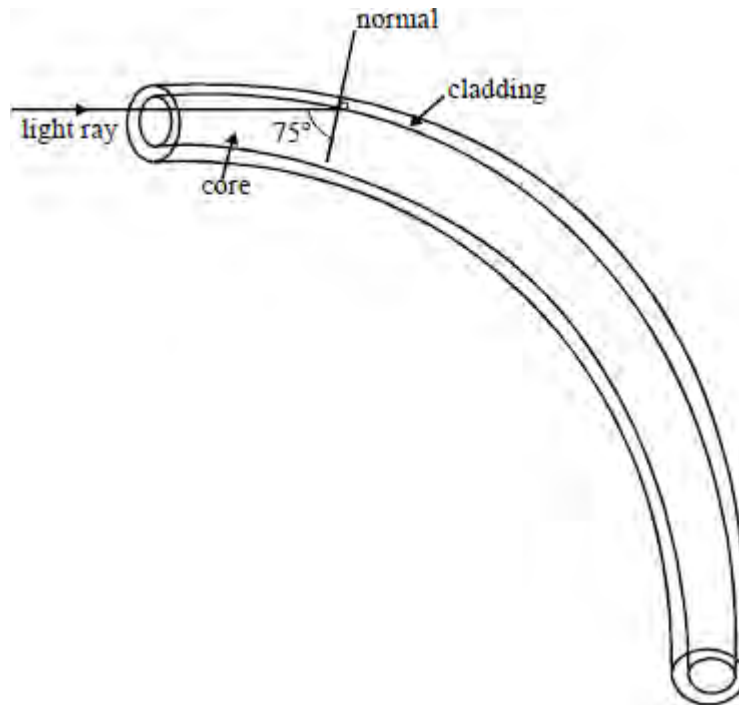
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(4)  
(Total 9 marks)

**Q6.** The diagram shows a glass optical fibre with a central core of refractive index 1.55 and a surrounding cladding of refractive index 1.40.



(a) Calculate the critical angle,  $C$ , for the boundary between these two types of glass.

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(3)

(b) Complete the path of the light ray shown in the diagram.

(2)

(c) State and explain whether the following changes in the optical fibre would increase or decrease the probability of light escaping from the fibre.



(i) increasing the refractive index of the cladding

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(ii) bending the fibre into a tighter curve

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**(3)**  
**(Total 8 marks)**