Remote Sensing – 2020 A2

1. Nov/2020/Paper_41/No.4

(a) Explain the principles of the **generation** of ultrasound waves for use in medical diagnosis.

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..... [4]

(b) The linear attenuation (absorption) coefficient for a parallel beam of ultrasound waves in air is $1.2\,cm^{-1}$.

The parallel beam passes through a layer of air of thickness 3.5 cm.

Calculate the ratio, in dB,

$$\frac{\text{intensity of beam after passing through the layer of air}}{\text{intensity of beam entering the layer of air}}.$$

ratio = ... dB [4]

[Total: 8]

2. Nov/2020/Paper_41/No.10

(a) Outline briefly the principles of computed tomography (CT scanning).

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..... [5]

(b) One section of a model designed to illustrate CT scanning is divided into four voxels. The pixel numbers K, L, M and N of the voxels are shown in Fig. 10.1.

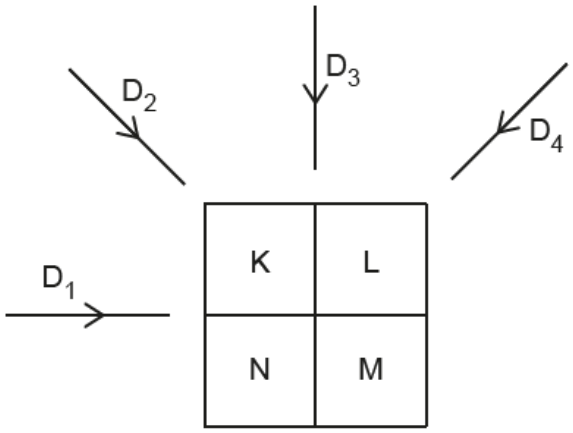

Fig. 10.1

The section is viewed, in turn, from four different directions D_1, D_2, D_3 and D_4, as shown in Fig. 10.1.

The detector readings for each direction are noted and these are summed to give the values shown in Fig. 10.2.

42	45
51	30

Fig. 10.2

The background reading is 24.

Determine the pixel numbers K, L, M and N shown in Fig. 10.1.

K = ...

L = ...

M = ...

N = ...

[3]

[Total: 8]

3. Nov/2020/Paper_42/No.7

Electrons in a beam are travelling at high speed in a vacuum. The electrons are incident on a metal target, causing X-ray radiation to be emitted.

The variation with wavelength λ of the intensity I of the emitted X-ray radiation is shown in Fig. 7.1.

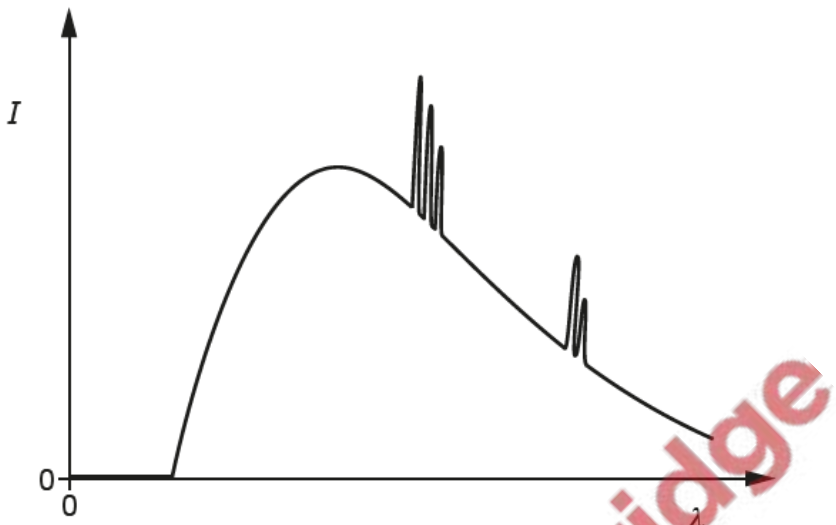

Fig. 7.1

Explain why:

(a) there is a continuous distribution of wavelengths

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..... [3]

(b) at certain wavelengths, there are narrow peaks of increased intensity.

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[Total: 6]

4. June/2020/Paper_41/No.4

(a) (i) By reference to an ultrasound wave, explain what is meant by *specific acoustic impedance*.

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..... [2]

(ii) An ultrasound wave is incident normally on the boundary between two media. The media have specific acoustic impedances Z_1 and Z_2.

State how the ratio

$$\frac{\text{intensity of ultrasound reflected from boundary}}{\text{intensity of ultrasound incident on boundary}}$$

depends on the relative magnitudes of Z_1 and Z_2.

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..... [2]

(b) (i) State what is meant by the *attenuation* of an ultrasound wave.

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..... [1]

(ii) A parallel beam of ultrasound is passing through a medium.
The incident intensity I_0 is reduced to $0.35 I_0$ on passing through a thickness of 0.046 m of the medium.

Calculate the linear attenuation coefficient μ of the ultrasound beam in the medium.

μ = ... m^{-1} [2]

[Total: 7]

5. June/2020/Paper_42/No.5

(a) Explain the principles of the **detection** of ultrasound waves for medical diagnosis.

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(b) By reference to specific acoustic impedance, explain why there is very little transmission of ultrasound waves from air into skin.

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[Total: 7]

(a) (i) Explain why ultrasound used in medical diagnosis is emitted in pulses.

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(ii) Explain the principles of the **detection** of ultrasound waves used in medical diagnosis.

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..... [3]

(b) The specific acoustic impedances Z of some media are given in Table 4.1.

Table 4.1

media	Z / kg m^{-2} s^{-1}
air	4.3×10^2
gel	1.5×10^6
soft tissue	1.6×10^6

(i) The specific acoustic impedances of two media are Z_1 and Z_2. The intensity reflection coefficient α for the boundary of these two media is given by:

$$\alpha = \frac{(Z_1 - Z_2)^2}{(Z_1 + Z_2)^2}.$$

Calculate, to three significant figures, the fraction of the ultrasound intensity that is reflected at a boundary between air and soft tissue.

α = ... [1]

(ii) Use your value in **(b)(i)** to explain why gel is applied to the surface of the skin during an ultrasound scan.

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..... [2]

[Total: 8]