SULIT

BAHAGIAN PEPERIKSAAN DAN PENILAIAN
JABATAN PENDIDIKAN POLITEKNIK DAN KOLEJ KOMUNITI
KEMENTERIAN PENDIDIKAN MALAYSIA

JABATAN KEJURUTERAAN ELEKTRIK

PEPERIKSAAN AKHIR

SESI JUN 2019

DEU50043 : MEDICAL IMAGING

TARIKH : 21 OKTOBER 2019
MASA : 8.30 PAGI – 10.30 PAGI (2 JAM)

Kertas ini mengandungi **SEBELAS (11)** halaman bercetak.

Bahagian A: Struktur (4 soalan)
Bahagian B: Esei (1 soalan)

Dokumen sokongan yang disertakan : Tiada

JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIARAHKAN

(CLO yang tertera hanya sebagai rujukan)

SULIT

SECTION A: 80 MARKS

BAHAGIAN A: 80 MARKAH

INSTRUCTION:

This section consists of **4 (FOUR)** structured questions. Answer **ALL** questions.

ARAHAN:

Bahagian ini mengandungi ***EMPAT (4)*** *soalan berstruktur. Jawab* ***SEMUA*** *soalan.*

CLO1 **QUESTION 1**

C2 ***SOALAN 1***

(a) Explain why do the changes in the filament heating current produces a change in the X-ray tube current (mA).

Terangkan mengapa perubahan dalam arus filamen pemanas menghasilkan perubahan pada arus tiub X-ray (mA).

(4 marks)

[4 markah]

CLO1 C3 (b) Provide the reasons why tungsten is used in the filament construction.

Sediakan sebab mengapa "tungsten" digunakan dalam pembinaan filament.

(8 marks)

[8 markah]

CLO1 C3 (c) Carry out the common procedure done by the radiographer in order to prolong the life-span of the x-ray tube.

Langkahkan prosedur yang sentiasa dilakukan oleh jurugambar untuk memanjangkan jangka hayat tiub sinar x-ray.

(8 marks)

[8 markah]

QUESTION 2

SOALAN 2

CLO1 C2

(a) Explain briefly the operational principle of computed tomography scanner (CT Scan) in producing radiographic images.

Terangkan dengan ringkas prinsip operasi pengimbas tomografi berkomputer (CT Scan) dalam menghasilkan imej radiografi.

(4 marks)

[4 markah]

CLO1 C3

(b) Illustrate the principal interactions of x-ray beam via patient's body which are involved in the production of a radiographic image.

Gambarkan interaksi utama sinar x melalui badan pesakit yang terlibat dalam pengeluaran imej radiografi.

(8 marks)

[8 markah]

CLO1 C3

(c) Calculate the heat generated (in Heat Units) by the following exposure 100 kVp, 200 mA, 0.5 s. If the maximum heat storage capacity of the anode disk is 25 000 Heat Units, state the reason if the exposure with the same adjustment can be repeated immediately.

Kirakan haba yang dihasilkan (dalam Unit Haba) dengan pendedahan berikut 100 kVP, 200 mA, 0.5 s. Jika kapasiti storan haba maksimum cakera anod ialah 25 000 Unit Haba, nyatakan sebab sekiranya pendedahan dengan pelarasan yang sama boleh diulang dengan segera.

(8 marks)

[8 markah]

QUESTION 3
SOALAN 3

CLO1
C2

(a) Explain the importance of "short half-life" and "emit γ-rays" as the criterias to be considered in selecting radionuclides for radionuclide imaging
Terangkan kepentingan "separuh hayat" dan "memancarkan sinar γ (gamma)" sebagai kriteria yang perlu dipertimbangkan dalam memilih radionuklida untuk pengimejan radionuklida.

(6 marks)
[6 markah]

CLO1
C2

(b) Discuss on how the design of collimator, scintillation crystal and the setting of PHA will affect gamma camera sensitivity.
Bincangkan bagaimana reka bentuk kolimator, kristal berkilat dan penetapan PHA(Pulse Height Analyser) akan mempengaruhi kepekaan kamera gamma.

(6 marks)
[6 markah]

CLO1
C3

(c) Sketch the Technetium ${}^{99}_{43}Tc^{m}$ generator which includes the following items

i. Lead shielding and Collection vial shielding
ii. Molybdenum/alumina column
iii. Plastic chasing
iv. Sterile Air Filter
v. Vial of eluent (Sterile saline)
vi. Evacuated collecting vial

The following statement can be used as a guideline which describes Technetium ${}^{99}_{43}\mathrm{Tc}^{\mathrm{m}}$ generator.

Molybdenum-98 is placed in a neutron stream, the nuclei of the molybdenum atoms can be made to absorb the neutrons to produce molybdenum-99. The capture of a neutron raises the energy of the resulting molybdenum-99 nuclei and each loses this energy by the prompt emission of a γ-ray. The reaction may be shown using the equation ${}^{98}_{42}\mathrm{Mo} + \mathrm{n} \rightarrow {}^{99}_{42}\mathrm{Mo} + \gamma$. A molybdenum-99/alumina column is in the centre of the generator. The molybdenum-99 has a half-life of 67 hours and decays to form technetium-99m by β^- particle emission as: ${}^{98}_{42}\mathrm{Mo} + \mathrm{n} \rightarrow {}^{99}_{43}\mathrm{Tc}^{\mathrm{m}} + \beta^- + \bar{\nu}$. The ${}^{99}_{43}\mathrm{Tc}^{\mathrm{m}}$ is eluted from the generator at regular intervals as sodium pertechnetate. This isotope, which is in liquid form, may then be used for a number of radionuclide imaging situations. The ${}^{99}_{43}\mathrm{Tc}^{\mathrm{m}}$ decays to ${}^{99}_{43}\mathrm{Tc}$ by the emission of β^-ray of energy 140 keV. The metastable isotope has a half-life of 6 hours.

Lakarkan penjana "Technetium" yang mana perlu memasukkan item berikut

i. *Perlindungan plumbum dan Perlindungan botol koleksi*
ii. *Kolum molibdenum / alumina*
iii. *Kerajang plastic*
iv. *Penapis udara steril*
v. *Vial of eluent (Saline Steril)*
vi. *Botol pengumpulan yang dipindahkan*

Kenyataan berikut boleh digunakan sebagai panduan yang menggambarkan penjana Technetium.

Molybdenum-98 diletakkan dalam aliran neutron, nukleus atom molibdenum boleh dibuat untuk menyerap neutron untuk menghasilkan molibdenum-99. Penangkapan neutron menimbulkan tenaga nukleus molibdenum-99 yang terhasil dan setiap kehilangan tenaga ini dengan pelepasan segera sinar γ. Reaksi boleh ditunjukkan menggunakan persamaan ${}^{98}_{42}Mo + n \rightarrow {}^{99}_{42}Mo + \gamma$. *Kolum Molibdenum-99 / alumina berada di tengah-tengah penjana. Molibdenum-99 mempunyai separuh hayat 67 jam dan mereput untuk membentuk technetium-99m dengan pelepasan zarah β sebagai:* ${}^{98}_{42}Mo + n \rightarrow {}^{99}_{43}Tc^{m} + \beta^{-} + \bar{\nu}$. ${}^{99}_{43}Tc^{m}$ *dicelupkan dari penjana pada selang masa tetap sebagai natrium pertechnetate. Isotop ini, yang dalam bentuk cecair, boleh digunakan untuk beberapa keadaan pengimejan radionuklida.* ${}^{99}_{43}Tc^{m}$ *mereput ke* ${}^{99}_{43}Tc$ *dengan pelepasan β-ray tenaga 140 keV. Isotop metastable mempunyai separuh hayat 6 jam.*

(8 marks)
[8 markah]

QUESTION 4

SOALAN 4

T6

CLO1 (a) List **FOUR** (**4**) requirements of magnet used in MRI system.

C1 *Senaraikan **EMPAT (4)** keperluan/ciri magnet yang digunakan dalam sistem MRI.*

(4 marks)

[4 markah]

CLO1 (b) Explain how MRI system can differentiate "normal tissue" and "pathologic

C2 tissue".

Terangkan bagaimana sistem MRI boleh membezakan "tisu biasa" dan "tisu patologi".

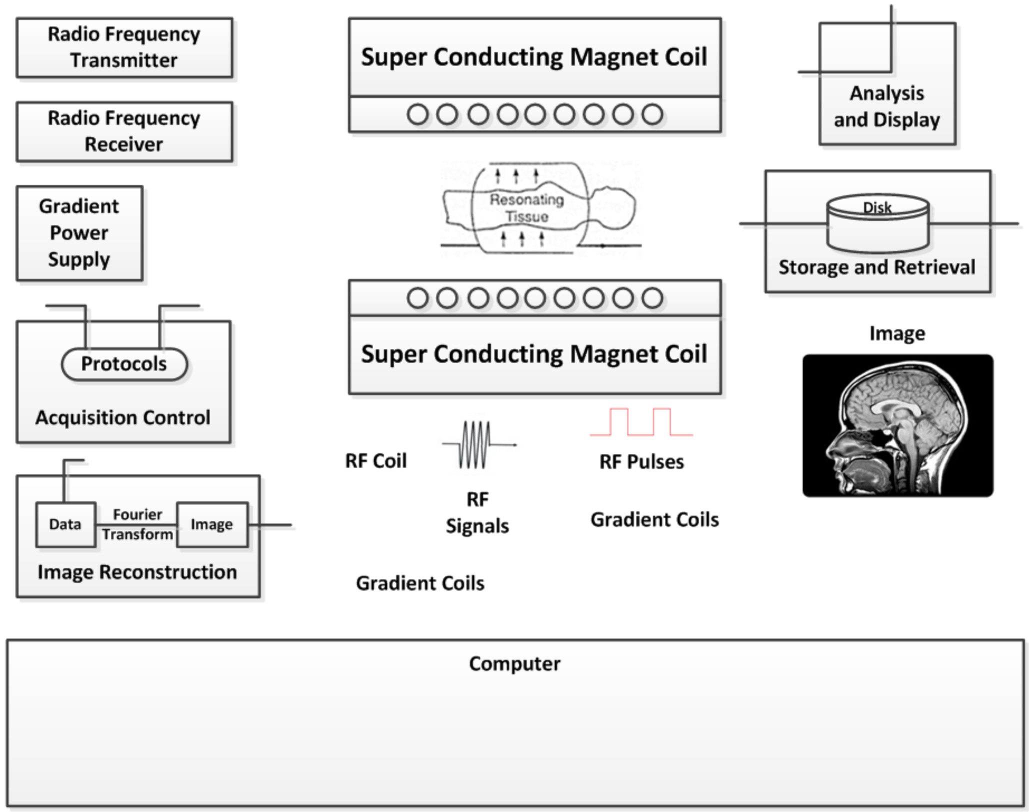
(6 marks)

[6 markah]

CLO1 (c) Organize the following components of MRI to complete a block diagram

C3 showing the MRI system.

Susun komponen MRI berikut untuk menjadi gambarajah blok yang lengkap menunjukkan sistem MRI.



- Super condcuting magnet coil
- Gradient coils
- RF coil
- RF pulses
- RF signals
- Radio Frequency Transmitter
- Radio Frequency Transmitter
- Gradient power supply

- Acquisiton Control
- Protocols
- Image Reconstruction
- Storage and Retrieval
- Analysis and display
- Image
- Data
- Image
- Disk

(10 marks)

[10 markah]

SECTION B: 20 MARKS

BAHAGIAN B: 20 MARKAH

INSTRUCTION:

This section consists of **ONE (1)** essay question. Answer the question.

ARAHAN:

Bahagian ini mengandungi ***SATU (1)*** *soalan esei. Jawab semua soalan.*

CLO1 **QUESTION 1**

C4 ***SOALAN 1***

This question refers to **Figure B1** of Ultrasound imaging.

Soalan ini merujuk kepada ***Rajah B1*** *Pengimejan ultrabunyi berikut.*

Consider the path of the ultrasound wave used to image an internal organ as shown in Figure B1. The signal received from the transducer is shown below the path. There are reflected signals received by the transducer at 1.3, 129 and 155 μs (μ second) as shown in the signal plot. The ultrasound wave passes through a thin layer of gel (ρ = 1,004 kg/m^3, c = 1,555 m/s), body tissue (ρ = 1,072 kg/m^3, c = 1,566 m/s), and the organ of interest (ρ = 1,040 kg/m^3, c = 1,530 m/s).

Pertimbangkan jalur gelombang ultrabunyi yang digunakan untuk mengimbas organ dalaman seperti ditunjukkan dalam Rajah B1 berikut. Isyarat yang diterima daripada pemindaharuh ditunjukkan di bawah laluan. Terdapat isyarat yang diterima pada pemindaharuh pada 1.3, 129 dan 155 μs seperti ditunjukkan dalam plot isyarat. Gelombang ultrasound bergerak/tersebar melalui lapisan nipis gel (ρ = 1,004 kg/m^3, c = 1,555 m/s), tisu badan (ρ = 1,072 kg/m^3, c = 1,566 m/s), dan organ yang dikehendaki (hendak dilihat) (ρ = 1,040 kg/m^3, c = 1,530 m/s).

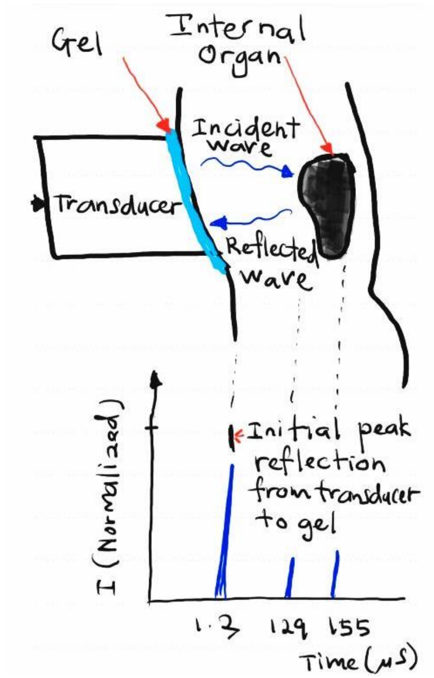


Figure B1: Ultrasound wave used to image an internal organ

i. Determine the distance to the body (gel thickness), to the organ, and the thickness of the organ based on the time of the signal received and the material properties.
Tentukan jarak ke badan (ketebalan gel), ke organ, dan ketebalan organ berdasarkan masa isyarat yang diterima dan sifat bahan.

ii. Determine the percentage of relative intensity of the ultrasound peaks received at 129 and 155 μs (μ second) by using the reflection coefficient equation. Remember that the wave has to travel to and back from each interface.
Tentukan peratus intensiti relatif puncak ultrabunyi yang diterima pada 129 dan 155 μs (μ saat) dengan menggunakan persamaan koefisian pantulan. Perlu diingatkan bahawa gelombang harus bergerak ke depan dan belakang dari setiap antaramuka.

iii. Illustrate the propagation of sound wave through various medium using the calculated value.
Gambarkan penyebaran gelombang bunyi melalui pelbagai medium menggunakan nilai yang dikira.

Given:

The Percentage of Reflection Coefficient

$(Peratus\ Pekali\ Pantulan), \alpha_R = \left(\frac{Z_2 - Z_1}{Z_2 + Z_1}\right)^2 \times 100\%$

The fraction of the incident energy that is *transmitted* across an interface is described by the transmission coefficient α_T

$where\ \alpha_T = \frac{4Z_1Z_2}{(Z_1+Z_2)^2} \times 100\%$, $\alpha_R + \alpha_T = 100\%$

Z_1 and Z_2 are the acoustic impedances of the two media.

Distance = Speed x Time

Acoustic impedance (g/cm^2s) = c, speed(cm/s) × ρ, density (g/cm^3)

Acoustic impedance of Air (g/cm^2s) = 0.0004×10^5

(20 marks)
[20 markah]

SOALAN TAMAT