Kingdom of Saudi Arabia
Ministry of Education
Umm Al-Qura University
College of Applied Sciences
Physics Department

Semester: 1st semester 1439-1440
Program: Medical Physics
Course: Physics of Medical Ultrasound.
Course Code: 403390-2
Exam: Final Exam
Time: 2 Hrs
Date: 10/4/1440 A. H
Total Marks: **50 Mark**

Student's Name: **Student ID:** **Group No.:**

Please answer Four questions only: **اجب عن اربعة اسئلة فقط مما يلى**
السؤال الاول اجبارى و الطالب يختار 3 اسئلة من باقى الاسئلة

[Question One] ***اجبارى*** *[20 Mark]*

Complete each sentence of the followings:

1) Waves that require an elastic medium to propagate through are called .....
2) In sound waves, the energy moves in the .....direction as the wave.
3) The frequencies of US used for diagnostic imaging are between for abdominal and pelvic scanning is performed with frequencies .....and ....., depending on the application.
4) Medical US is produced in beams that are usually focused into a ….....……. Area, and the beam are described in terms of .....**,** defined as the beam ".....".
5) For US intensity is related to maximum pressure (P_m) in the medium by following expression..... while, US intensity level is related to the sound pressure by a relation……..... .
6) An US beam is incident on a liver-air interface, where Z_{liver}= 1.6x10^{-4} Kg/m^2.s and Z_{air}= 0.0004 x10^{-4} Kg/m^2.s, thus the fraction intensity coefficient is given by …….....while, the transmission fraction coefficient is given by…….....……
7) For a 5 MHz- US wave transducer travelling round trip to a depth of 4 cm in liver and reflected from an encapsulated air pocket (100% reflects at the boundary) knowing that 0.5 dB/cm-MHz, so that the attenuation coefficient is ….....

and the total distance travelled by US pulse is ……and the total attenuation (total energy loss) is α_{total} …… …

8) For a body fat medium with density 925 Kg/m^3 and speed of US beam is 1450 m/s, the acoustic impedance of the medium is … …….

9) A (an) .....is anything that converts one form of energy into another form.

10) In the case of diagnostic US the transducer converts .....energy to .....energy and vice versa.

11) The frequency of a transducer is determined by the .....and .....of the crystal.

12) For US beam, After some distance, however the beam starts to divergence of the beam, it is described as of .....and the diverging part of the beam is called .....

13) In US A-mode, The oscilloscope presents a graph of .....representing ....on the ordinate, or *y-axis*, as a function of .....on the abscissa, or *x-axis*.

14) Most B mode images are viewed as .....on ....., so regions in the patient that are .....correspond to regions in the image that are_.....

15) The M-mode ("…….structures" mode) presentation of ultrasound images is designed specifically to depict .....structures.

16) The most frequent application of M-mode scanning is ....., where, the motion of various interfaces in the heart is depicted graphically on a ……

17) A transducer that emits many frequencies on either side of the main frequency has a ....., while a transducer that emits only a few frequencies on either side of the main frequency is called .....transducer .

18) Artificial material's piezoelectric material crystal are such as ....., ……, and ……

19) During generation of US beam from a certain crystal, while applying of a (an) .....is reversed in polarity, the .....is also reversed in polarity.

اجب عن ثلاثة اسئلة فقط مما يلى:

[Question Two] *[10 Marks]*

A- What is the length of the Fresnel zone for a 10-mm-diameter, 2-MHz unfocused ultrasound transducer?

B- Put (√)sign for the right sentence or (X) sign for wrong sentence and re-correct the wrong one:-		
1)	Ultrasound waves are scattered by the medium part of the beam's energy that is converted into other forms of energy.	( )
2)	US is "reflected" if there is a 180° defection of all or part of the beam	( )
3)	If part of an US beam changes direction at higher than 180°, the event is usually described as "scatter."	( )
4)	A travelling US beam in a muscle tissues medium with a speed of 1590 m/s, while its density is 1075 Kg/m^3, the impedance of a medium is 1307.4 $Kg/m^2.s$.	( )
5)	US power lost from the beam (scattered power) is proportional to the frequency of the incident wave.	( )
6)	Scattering of US in a smooth surface is larger than rough surface	( )
7)	As a human body tissues are homogenous medium, the mechanism of overall attenuation giving by absorption, scattering and specular reflection.	( )
8)	At the half-value thickness (HVT) $X_{1/2}$,the intensity I decline by a factor 0.5 in every (0.7/ α).	( )
9)	The greater the value of the attenuation coefficient, the more slower is the decay, and the shorter the half -value thickness.	( )
10)	Both absorption and scattering are strongly dependent on frequency and is therefore the overall attenuation is also frequency dependent.	( )

[Question Three] *[10 Marks]*

A- A steel cable of cross-section area $2.83x10^{-3}$ m^2 is kept under a tension of $1.00x10^4$ N. The density of steel is 7860 kg/m^3 (this is not the linear density). At what speed does a transverse wave move along the cable?

B- Compare with <u>sketching the details and equations</u> between the focused and unfocused beam of an ultrasound beam?

[Question Four] *[10 Marks]*

A- How many scan lines may be obtained during a scan of a patient when the depth of view (DOV) is 8 cm if the total scan time is 13.4 msec? Assume sequential acquisition of scan lines?

B- Discuss, in detail, <u>with full sketching</u>, the procedure of generating of US from a PZT crystal?

[Question Five] *[10 Marks]*

A- For the muscle–fats boundary, while ultrasound wave incident on, and by using the acoustic impedance of different materials, <u>calculate</u>:

1. ***Intensity Reflection Coefficient?***
2. ***Intensity Transmission Coefficient?***
3. ***Pressure amplitude reflection coefficient?***
4. ***What will be the actual intensity reflected at the boundary?***

(For an intensity of 40 mW/cm^2)

(Knowing that the muscle and fat acoustic impedance: Z_1= 1.71 rayl & Z_1= 1.34 rayl)

<u>B- Give a reason or reasons for each of the following items:</u> ***<u>(Answer 5 Items Only)</u>***

(1) Many crystals exhibit the piezoelectric effect, but unsuitable as ultrasound transducers?

(2) In US transducer, the tube that contains the crystal is metallic?

(3) Strong reflection prevents good coupling, and this would occur if the crystal was placed directly on the skin?

(4) Resonance frequency of a transducer to give US?

(5) The transducer crystal emits more than one single frequency?

(6) Presence of a damping block in the back of the transducer?

(7) For medical applications of US beams with long Fresnel Zone are preferred?

With best wishes