Republic of Yemen

Ministry of Education & Higher Research

Council of Academic Accreditation & Quality Assurance of

Higher Education (CAQA)

21 septamber University of Medical and Applied Science

Faculty of Applied Medical Science

Department of Medical Radiology and Imaging Technology

Program of Radiologic Technology and Medical Imaging

Course Specification of

Ultrasound Physics

Course Code. (____)

2024

I. General Information:

1.	Course Title:	Ultrasound Physics				
2.	Course Code:					
3.	Credit Hours:	Credit Hours	Theory Contact Hours		Practical Contact Hours	
			Lecture	Tutorial/ Seminar	Lab	Clinical
		2	2	--	--	--
4.	Level/ Semester at which this Course is offered:	4th Level / 1st Semester				
5.	Pre –Requisite (if any):	Radiation physics I&II				
6.	Co –Requisite (if any):	None				
7.	Program (s) in which the Course is Offered:	Bachelor of Radiologic Technology and Medical Imaging				
8.	Language of Teaching the Course:	English				
9.	Location of Teaching the Course:	Faculty of Applied Medical Science				
10.	Prepared by:					
11.	Date and Number of Approval by Council:					

II. Course Description:

This course introduces students to the principles and applications of ultrasound in medical imaging. It focuses on the fundamental physics of sound waves, tissue interactions, and how ultrasound imaging systems function. Topics include the operation of transducers, Doppler effects, imaging modes, artifacts, and quality assurance in ultrasound imaging. Emphasis is placed on understanding diagnostic ultrasound's technical aspects, safety protocols, and recent technological advancements.

III. Course Intended Learning Outcomes (CILOs) : Upon successful completion of the course, students will be able to:		Referenced PILOs		
A. Knowledge and Understanding:		**I, P or M/A**		
a1	Understand sound wave propagation and interaction with tissues.	**M**	**A1**	Demonstrate an understanding of fundamental knowledge of Biomedical sciences (Biology, Biophysics, Anatomy, Physiology, Sectional anatomy, and medical imaging technique).
a2	Explain the principles of ultrasound transducers and image formation.	**M**	**A2**	Explanation of the principles and procedures of medical imaging acquisitions, medical imaging technique, and Radiological Technology Sciences as well as patient positioning in computed radiography and MRI technique.
a3	Recognize the implications of ultrasound artifacts and safety principles in clinical applications.	**M**	**A3**	Exhibit professional characteristics required by the radiologic technology profession.
B. Intellectual Skills:				
b1	Analyze the effects of tissue properties on ultrasound transmission.	**M**	**B3**	Analyze and evaluate evidence-based information needed in medical imaging practice.
b2	Evaluate image quality and identify artifacts and limitations.	**M**		
C. Professional and Practical kills:				
c1	Explain the operational steps for optimizing diagnostic ultrasound systems.	**M**	**C2**	Apply technical skills in using medical imaging devices, tools, and materials in radiological technology practice.
c2	Apply quality assurance and safety protocols in ultrasound imaging.	**M**	**C1**	Execute quality management system and standard procedures in radiological technology practice.
D. Transferable Skills:				

d1	Demonstrate teamwork in solving ultrasound imaging problems.	**A**	**D4**	Function effectively as an individual, as a member, or leader of a team engaged in appropriate activities to the radiologic technology disciplines to accomplish a common goal.
d2	Communicate technical concepts and solutions effectively.	**A**	**D1**	Communicate effectively with clinicians, patients, and support staff.
I= Introduced, P=Practiced or M/A= Mastered/Advanced				

(A) Alignment of Course Intended Learning Outcomes (Knowledge and Understanding) to Teaching Strategies and Assessment Methods:

Course Intended Learning Outcomes		Teaching Strategies	Assessment Strategies
a1	Understand sound wave propagation and interaction with tissues.	▪ Lectures, visual aids, discussions	▪ Written exams, quizzes
a2	Explain the principles of ultrasound transducers and image formation.		
a3	Recognize the implications of ultrasound artifacts and safety principles in clinical applications.		

(B) Alignment of Course Intended Learning Outcomes (Intellectual Skills) to Teaching Strategies and Assessment Methods:

Course Intended Learning Outcomes		Teaching Strategies	Assessment Strategies
b1	Analyze the effects of tissue properties on ultrasound transmission.	▪ Case studies, group work, image analysis	▪ Case study analysis, practical exams
b2	Evaluate image quality and identify artifacts and limitations.		

(C) Alignment of Course Intended Learning Outcomes (Professional and Practical Skills) to Teaching Strategies and Assessment Methods:

Course Intended Learning Outcomes	Teaching Strategies	Assessment Strategies

c1	Explain the operational steps for optimizing diagnostic ultrasound systems.	▪ Quality assurance exercises, safety demonstrations	▪ Practical exams, lab reports
c2	Apply quality assurance and safety protocols in ultrasound imaging.		

(D) Alignment of Course Intended Learning Outcomes (Transferable Skills) to Teaching Strategies and Assessment Methods:

Course Intended Learning Outcomes		Teaching Strategies	Assessment Strategies
d1	Demonstrate teamwork in solving ultrasound imaging problems.	▪ Role-playing, presentations, group projects	▪ Group evaluations
d2	Communicate technical concepts and solutions effectively.		

IV. Course Contents:

A. Theoretical Aspect:

No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours	Learning Outcomes (CILOs)
1	**Introduction to Ultrasound Physics**	– Properties of sound waves, frequency, wavelength, amplitude	Week 1	2	a1
2	**Propagation of Sound Waves**	– Acoustic impedance, wave velocity in tissues	Week 2	2	a1, b1
3	**Ultrasound Transducers**	– Piezoelectric effect, transducer types, beam patterns	Week 3	2	a2, c1
4	**Image Formation**	– Pulse-echo principle, imaging modes (B-mode, M-mode)	Week 4	2	a2, b1
5	**Doppler Ultrasound**	– Principles, frequency shifts, applications	Week 5	2	a1, b1
6	**Interaction with Tissues**	– Reflection, refraction, attenuation, scattering	Week 6	2	a1, b2

No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours	Learning Outcomes (CILOs)
7	**Mid-term Exam**	– All Previous topics	Week 7	2	a1, a2, b1, b2, c1
8	**Ultrasound Artifacts**	– Types: shadowing, enhancement, resolution limitations	Week 8	2	a3, b2
9	**Safety in Ultrasound**	– Bioeffects, patient/operator safety	Week 9	2	a3, c2
10	**Quality Assurance in Ultrasound**	– Calibration, performance tests, standardization	Week 10	2	c1, c2
11	**Cardiovascular Ultrasound**	– Doppler studies in vascular/cardiac imaging	Week 11	2	a2, b2
12	**Emerging Technologies**	– Elastography, fusion imaging, 3D ultrasound	Week 12	2	a2, b2
13	**Imaging Modes**	– Advanced applications (3D, contrast-enhanced)	Week 13	2	a1, a2
14	**Obstetrics and Gynecology**	– Ultrasound applications in OB/GYN	Week 14	2	a2, b2
15	**Ultrasound Limitations**	– Practical challenges, future advancements	Week 15	2	a3, d2
16	**Final Exam**	– All topics	Week 16	2	a1, a2, a3, b1, b2, c1, c2
Number of Weeks /and Units Per Semester			**16**	**32**	

B. Practical Aspect (Lab/Clinical) (if any):

No.	Tasks/ Experiments	Number of Weeks	Contact Hours	Learning Outcomes (CILOs)
1	**None**			

No.	Tasks/ Experiments	Number of Weeks	Contact Hours	Learning Outcomes (CILOs)
2				
3				
Number of Weeks /and Units Per Semester				

C. Tutorial Aspect (if any):

No.	Tutorial	Number of Weeks	Contact Hours	Learning Outcomes (CILOs)
1	None			
2				
3				
Number of Weeks /and Units Per Semester				

VII. Teaching Strategies:

- Lectures
- Image Analysis Exercises
- Case Studies
- Group Discussions

VII. Assessment Methods:

- Written Exams
- Case Study Analysis
- Quizzes
- Reports

VII. Assignments:

No.	Assignments	Week Due	Mark	Aligned CILOs (symbols)
1				

No.	Assignments	Week Due	Mark	Aligned CILOs (symbols)
2				
Total				

VIII. Schedule of Assessment Tasks for Students During the Semester:

No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment	Aligned Course Learning Outcomes
1	**Quizzes**	Weeks 4, 8	5	5%	a1, a2, b1
2	**Mid-term Exam**	Week 7	10	10%	a1, a2, a3
3	**Case Study Analysis**	Week 10	10	10%	b2, c1, d1
4	**Assignments and Reports**	Week 12	5	5%	c2, d2
5	**Final Exam**	Week 14	70	70%	a1, a2, a3, b1, b2
Total			**100**	**100 %**	

IX. Learning Resources:

1- Required Textbook(s) (maximum two):

1- Peter Hoskins, Kevin Martin, Abigail Thrush, 2019, Diagnostic Ultrasound: Physics and Equipment, Third Edition, CRC Press.
2- Robert Gill, 2020, The Physics and Technology of Diagnostic Ultrasound: A Practitioner's Guide, Second Edition, High Frequency Publishing.

2- Essential References:

1- Matthias Hofer, 2020, Ultrasound Teaching Manual: The Basics of Performing and Interpreting Ultrasound Scans, 4th Edition, Thieme.
2- Thomas L. Szabo, Peter Kaczkowski, 2023, Essentials of Ultrasound Imaging, 1st Edition, Elsevier.
3- Frederick W. Kremkau, 2019, Sonography Principles and Instruments, 10th Edition, Elsevier.

3- Electronic Materials and Web Sites etc.:

Electronic Materials and Websites

- www.ultrasound-physics.com

- www.radiologyinfo.org

X. Course Policies: (Based on the Uniform Students' By law (2007)	
1	**Class Attendance:** Class Attendance is mandatory. A student is considered absent and shall be banned from taking the final exam if his/her absence exceeds 25% of total classes.
2	**Tardiness:** A student will be considered late if he/she is not in class after 10 minutes of the start time of class.
4	**Assignments & Projects:** Assignments and projects must be submitted on time. Students who delay their assignments or projects shall lose the mark allocated for the same.
5	**Cheating:** Cheating is an act of fraud that results in the cancelation of the student's exam or assignment. If it takes place in a final exam, the penalties stipulated for in the Uniform Students' Bylaw (2007) shall apply.
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7	**Other policies:** The University official regulations in force will be strictly observed and students shall comply with all rules and regulations of the examination set by the Department, Faculty and University Administration.
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Faculty of Applied Medical Science

Department of Medical Radiology and Imaging Technology

Program of Radiologic Technology and Medical Imaging

Course Plan (Syllabus) of

Ultrasound Physics

Course Code. .....

I. Information about Faculty Member Responsible for the Course:								
Name of Faculty Member:		Office Hours						
Location& Telephone No.:	-----							
E-mail:	--@--.--	SAT	SUN	MON	TUE	WED	THU	

2024/2025

Prepared by:	Reviewed by:	Head of the Department:	Quality Unit:	Dean:
	Dr. -----	Dr. Awadh Al-Kubati	Dr. Mohammed Al-shamahi	Dr. Abdulsalam Dalaq

I. General Information:

12.	**Course Title:**	Ultrasound Physics				
13.	**Course Code:**					
14.	**Credit Hours:**	**Credit Hours**	**Theory Contact Hours**		**Practical Contact Hours**	
			Lecture	**Tutorial/ Seminar**	**Lab**	**Clinical**
		2	2	--	--	--
15.	**Level/ Semester at which this Course is offered:**	4th Level / 1st Semester				
16.	**Pre –Requisite (if any):**	Radiation physics I&II				
17.	**Co –Requisite (if any):**	None				
18.	**Program (s) in which the Course is Offered:**	Bachelor of Radiologic Technology and Medical Imaging				
19.	**Language of Teaching the Course:**	English				
20.	**Location of Teaching the Course:**	Faculty of Applied Medical Science				
21.	**Prepared by:**					
22.	**Date and Number of Approval by Council:**					

II. Course Description:

This course introduces students to the principles and applications of ultrasound in medical imaging. It focuses on the fundamental physics of sound waves, tissue interactions, and how ultrasound imaging systems function. Topics include the operation of transducers, Doppler effects, imaging modes, artifacts, and quality assurance in ultrasound imaging. Emphasis is placed on understanding diagnostic ultrasound's technical aspects, safety protocols, and recent technological advancements.

III. Course Intended Learning Outcomes (CILOs) :
Upon successful completion of the course, students will be able to:

	A. Knowledge and Understanding:
a1	Understand sound wave propagation and interaction with tissues.
A2	Explain the principles of ultrasound transducers and image formation.
A3	Recognize the implications of ultrasound artifacts and safety principles in clinical applications.
	B. Intellectual Skills:
b1	Analyze the effects of tissue properties on ultrasound transmission.
B2	Evaluate image quality and identify artifacts and limitations.
	C. Professional and Practical kills:
c1	Explain the operational steps for optimizing diagnostic ultrasound systems.
C2	Apply quality assurance and safety protocols in ultrasound imaging.
	D. Transferable Skills:
d1	Demonstrate teamwork in solving ultrasound imaging problems.
D2	Communicate technical concepts and solutions effectively.

IV. Course Contents:

A. Theoretical Aspect:

No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours
1	**Introduction to Ultrasound Physics**	– Properties of sound waves, frequency, wavelength, amplitude	Week 1	2
2	**Propagation of Sound Waves**	– Acoustic impedance, wave velocity in tissues	Week 2	2
3	**Ultrasound Transducers**	– Piezoelectric effect, transducer types, beam patterns	Week 3	2
4	**Image Formation**	– Pulse-echo principle, imaging modes (B-mode, M-mode)	Week 4	2

No.	Units/Topics List	Sub Topics List	Number of Weeks	Contact Hours
5	**Doppler Ultrasound**	– Principles, frequency shifts, applications	Week 5	2
6	**Interaction with Tissues**	– Reflection, refraction, attenuation, scattering	Week 6	2
7	**Mid-term Exam**	– All Previous topics	Week 7	2
8	**Ultrasound Artifacts**	– Types: shadowing, enhancement, resolution limitations	Week 8	2
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15	**Ultrasound Limitations**	– Practical challenges, future advancements	Week 15	2
16	**Final Exam**	– All topics	Week 16	2
Number of Weeks /and Units Per Semester			**16**	**32**

B. Practical Aspect (Lab/Clinical) (if any):

No.	Tasks/ Experiments	Number of Weeks	Contact Hours
1	**None**		
2			

No.	Tasks/ Experiments	Number of Weeks	Contact Hours
Number of Weeks /and Units Per Semester		11	22

C. Tutorial Aspect (if any):

No.	Tutorial	Number of Weeks	Contact Hours
1	None		
2			
3			
Number of Weeks /and Units Per Semester			

VII. Teaching Strategies:

- Lectures
- Image Analysis Exercises
- Case Studies
- Group Discussions

VII. Assessment Methods:

- Written Exams
- Case Study Analysis
- Quizzes
- Reports

VII. Assignments:

No.	Assignments	Week Due	Mark
1			
2			
Total			10

VIII. Schedule of Assessment Tasks for Students During the Semester:

No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment
1	**Quizzes**	Weeks 4, 8	5	5%
2	**Mid-term Exam**	Week 7	10	10%
3	**Case Study Analysis**	Week 10	10	10%
4	**Assignments and Reports**	Week 12	5	5%
5	**Final Exam**	Week 14	70	70%
Total			**100**	**100 %**

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