MSc program, Biomedical Engineering Department

Course Unit Title	Ultrasound Imaging and Doppler Techniques
Course Unit Code	BME518
Type of Course Unit	Elective
Level of Course Unit	Master of Science
National Credits	3
Number of ECTS Credits Allocated	10
Theoretical (hour/week)	4
Practice (hour/week)	-
Laboratory (hour/week)	-
Year of Study	-
Semester when the course unit is delivered	-
Course Coordinator	Assist. Prof. Dr. Deniz Bedel
Name of Lecturer (s)	Assist. Prof. Dr. Deniz Bedel
Name of Assistant (s)	-
Mode of Delivery	Face to Face.
Language of Instruction	English
Prerequisites	-
Recommended Optional Programme Components	-

Course description:

The course is designed for biomedical engineering master students. The purpose of the course is to provide detailed information on technical aspects of ultrasound imaging. Biomedical diagnostic ultrasound imaging systems and the physical principles of Ultrasound and Doppler techniques are introduced in detail. Students are provided with overviews of the major physical techniques that engineers have used to explore in biomedical engineering level.

Objectives of the Course:

To provide the students with an understanding of critical evaluation of scientific literature and scientific and engineering research and development in this field, as well as the skills required to present and support their findings.

Learning Outcomes

At the end of the course the student should be able to		Assessment
1	Develop a thorough understanding on basics of biomedical diagnostic ultrasound imaging devices.	1
2	Develop a thorough understanding on physical principles of ultrasound imaging and Doppler effect.	1, 2
3	Develop a thorough understanding on principles of Ultrasound imaging system electronics and instrumentations.	1, 2

4	Develop a thorough understanding on clinical applications of Ultrasound and Doppler Ultrasound modalities.	1, 3, 4

Assessment Methods: 1. Written Exam, 2. Assignment, 3. Project/Report, 4. Presentation, 5. Lab. Work

Course's Contribution to Program

		CL
1	Apply the rules of scientific research and ethics	4
2	Discuss complex biomedical engineering issues as well as own research results comprehensively and in the context of current international research and present these in writing and orally	5
3	Solve problems by systems analytical thinking both in subject specific and interdisciplinary concepts	5
4	Combine specialized knowledge of various component disciplines	5
5	Carry out in dependent scientific work and organize (capacity of teamwork), Conduct and lead more complex projects	4
6	To assess the social and environment-related effects of their actions	3

CL: Contribution Level (1: Very Low, 2: Low, 3: Moderate, 4: High, 5: Very High)

Course Contents

Week	Chapter	Topics	Assessment
1		Brief history of ultrasound imaging, waves, acoustics basics, wavelength, frequency, acoustic pressure.	
2		**Acoustic wave equation:** Equation of state, conservation of mass, conservation of momentum, linear wave equation.	
3		**Plane waves:** Acoustic energy, power, intensity, solutions to the 1D wave equation, single frequency plane waves, spherical and cylindrical waves.	
4		**Scattering and absorption:** Acoustic impedance, reflection, Snell's law, scattering, acoustic attenuation, absorption, time gain compensation.	
5		**Nonlinear acoustics:** Material nonlinearity, convective nonlinearity, nonlinear propagation, wave steepening, harmonic generation, shock parameter, tissue harmonic	

		imaging.	
6		**Bubbles and bioeffects :** Ultrasound contrast agents, cavitation, radiation force, streaming, bioeffects, safety, mechanical and thermal indices.	
7		**Ultrasound transducers:** Piezoelectric generation and detection of ultrasound, piezoelectric materials, transducer frequency response, quarter wave matching layers, focused and planar transducer beam patterns, reciprocity principle.	
8		Midterm	Midterm Exam
9		**Principles of imaging:** image formation, time gain compensation, A, B and M imaging modes.	
10		**Imaging instrumentation:** B- mode scanners, linear arrays, electronic transmit and receive focusing, phased arrays, contrast, spatial resolution, image artefacts.	
11		**Doppler ultrasound:** Hemodynamics, the Doppler equation, CW and pulsed Doppler, demodulation techniques, colour Doppler, power Doppler.	
12		**Clinical applications of diagnostic ultrasound:** obstetrics, abdomen, cardiovascular, breast eye.	
13		**Hybrid optical-ultrasound imaging modalities:** Photoacoustic imaging, ultrasound modulated optical tomography.	
14		Recent Developments in Medical Imaging & Revision Week	
15		FINAL EXAM	Final Exam.

Recommended Sources

Lecture Notes.

Assessment

Project	15%	
Midterm Exam	30%	Written Exam
Final Exam	50%	Written Exam

Attendance	5%	
Total	100%	

Assessment Criteria

Final grades are determined according to the Near East University Academic Regulations for Undergraduate Studies

Course Policies

1. Attendance to the course is mandatory.
2. Late assignments will not be accepted unless an agreement is reached with the lecturer.
3. Students may use calculators during the exam.
4. Cheating and plagiarism will not be tolerated. Cheating will be penalized according to the Near East University General Student Discipline Regulations

ECTS allocated based on Student Workload

Activities	Number	Duration (hour)	Total Workload(hour)
Course duration in class (including Exam weeks)	15	4	60
Labs and Tutorials	10	10	100
Assignment	-	-	-
Project/Presentation/Report	3	10	30
E-learning activities	-	-	-
Quizzes	-	-	-
Midterm Examination	1	6	6
Final Examination	1	12	12
Self Study	15	7	105
Total Workload			313
Total Workload/30(h)			10.4
ECTS Credit of the Course			10