DMS-235B: DOPPLER PRINCIPLES AND INSTRUMENTATION

Cuyahoga Community College

Viewing: DMS-235B : Doppler Principles and Instrumentation

Board of Trustees:
March 2020

Academic Term:
Fall 2020

Subject Code
DMS - Diagnostic Medical Sonography

Course Number:
235B

Title:
Doppler Principles and Instrumentation

Catalog Description:
Study of resolution, display modes, hemodynamics, Doppler principles and related instrumentation as it relates to ultrasound.

Credit Hour(s):
1

Lecture Hour(s):
1

Requisites

Prerequisite and Corequisite
DMS-1071 Concepts of Physics in Diagnostic Sonography and ENG-0990 Language Fundamentals II or appropriate score on English Placement Test.

I. ACADEMIC CREDIT

Academic Credit According to the Ohio Department of Higher Education, one (1) semester hour of college credit will be awarded for each lecture hour. Students will be expected to work on out-of-class assignments on a regular basis which, over the length of the course, would normally average two hours of out-of-class study for each hour of formal class activity. For laboratory hours, one (1) credit shall be awarded for a minimum of three laboratory hours in a standard week for which little or no out-of-class study is required since three hours will be in the lab (i.e. Laboratory 03 hours). Whereas, one (1) credit shall be awarded for a minimum of two laboratory hours in a standard week, if supplemented by out-of-class assignments which would normally average one hour of out-of-class study preparing for or following up the laboratory experience (i.e. Laboratory 02 hours). Credit is also awarded for other hours such as directed practice, practicum, cooperative work experience, and field experience. The number of hours required to receive credit is listed under Other Hours on the syllabus. The number of credit hours for lecture, lab and other hours are listed at the beginning of the syllabus. Make sure you can prioritize your time accordingly. Proper planning, prioritization and dedication will enhance your success in this course.

The standard expectation for an online course is that you will spend 3 hours per week for each credit hour.

II. ACCESSIBILITY STATEMENT

If you need any special course adaptations or accommodations because of a documented disability, please notify your instructor within a reasonable length of time, preferably the first week of the term with formal notice of that need (i.e. an official letter from the Student Accessibility Services (SAS) office). Accommodations will not be made retroactively.
For specific information pertaining to ADA accommodation, please contact your campus SAS office or visit online at https://www.tri-c.edu/student-accessibility-services/. Blackboard accessibility information is available at http://access.blackboard.com.
Eastern (216) 987-2052 - Voice. (216) 987-2423 - Fax
Metropolitan (216) 987-4344 – Voice.
(216) 987-3257 - Fax
Western (216) 987-5079 – Voice. (216) 987-5118 - Fax.
III. ATTENDANCE TRACKING

Regular class attendance is expected. Tri-C is required by law to verify the enrollment of students who participate in federal Title IV student aid programs and/or who receive educational benefits through other funding sources. Eligibility for federal student financial aid is based in part on enrollment status.

Students who do not attend classes for the entire term are required to withdraw from the course(s). Additionally, students who withdraw from a course or stop attending class without officially withdrawing may be required to return all or a portion of their financial aid based on the date of last attendance. Students who do not attend the full session are responsible for withdrawing from the course(s).

Tri-C is responsible for identifying students who have not attended a course before financial aid funds can be applied to students’ accounts.

Therefore, attendance is recorded in the following ways:

- For in-person and blended-learning courses, students are required to attend the course by the 15th day of the semester (or equivalent for terms shorter than five weeks) to be considered attending. Students who have not met all attendance requirements for in-person and blended courses, as described herein, within the first two weeks or equivalent, will be considered not attending.

- For online courses, students are required to login at least two times per week and submit one assignment per week for the first two weeks of the semester, or equivalent to the 15th day of the term. Students who have not met all attendance requirements for online courses, as described herein, within the first two weeks or equivalent, will be considered not attending.

At the conclusion of the first two weeks of a semester or equivalent, instructors report any registered students who have “Never Attended” a course. Those students will be administratively withdrawn from that course. However, after the time period in the previous paragraphs, if a student stops attending a class or wants or needs to withdraw, for any reason, it is the student’s responsibility to take action to withdraw from the course. Students must complete and submit the appropriate Tri-C form by the established withdrawal deadline.

Tri-C is required to ensure that students receive financial aid only for courses that they attend and complete. Students reported for not attending at least one of their registered courses will have all financial aid funds held until confirmation of attendance in registered courses has been verified. Students who fail to complete at least one course may be required to repay all or a portion of their federal financial aid funds and may be ineligible to receive future federal financial aid awards. Students who withdraw from classes prior to completing more than 60 percent of their enrolled class time may be subject to the required federal refund policy.

If illness or emergency should necessitate a brief absence from class, students should confer with instructors upon their return. Students having problems with coursework due to a prolonged absence should confer with the instructor or a counselor.

IV. LEARNING OUTCOMES ASSESSMENT

Occasionally, in addition to submitting assignments to their instructors for evaluation and a grade, students will also be asked to submit completed assignments, called ‘artifacts,’ for assessment of course and program outcomes and the College’s Essential Learning Outcomes (ELOs). The artifacts will be submitted in Blackboard or a similar technology. The level of mastery of the outcome demonstrated by the artifact DOES NOT affect the student’s grade or academic record in any way. However, some instructors require that students submit their artifact before receiving their final grade. Some artifacts will be randomly selected for assessment, which will help determine improvements and support needed to further student success. If you have any questions, please feel free to speak with your instructor or contact the Learning Outcomes Assessment office.

V. CONCEALED CARRY STATEMENT

College policy prohibits the possession of weapons on college property by students, faculty and staff, unless specifically approved in advance as a job-related requirement (i.e., Tri-C campus police officers) or, in accordance with Ohio law, secured in a parked vehicle in a designated parking area only by an individual in possession of a valid conceal carry permit.

As a Tri-C student, your behavior on campus must comply with the student code of conduct which is available on page 29 within the Tri-C student handbook, available at http://www.tri-c.edu/student-resources/documents/studenthandbook.pdf You must also comply with the College’s Zero Tolerance for Violence on College Property available at http://www.tri-c.edu/policies-and-procedures/documents/3354-1-20-10-zero-tolerance-for-violence-policy.pdf

VI. CORONAVIRUS/COVID-19 STATEMENT

Students are responsible for adhering to all College health and safety guidance, including that which relates to the COVID-19 pandemic.

Public health requirements and standards are changing rapidly, and the College is adapting its guidance accordingly. Please check your Tri-C email and visit tri-c.edu/coronavirus regularly for updates.

All students must adhere to the following general guidelines, until further notice:

- Remain at home if you are ill or experiencing symptoms of illness. Do not attend any in-person class or gathering.
• Notify your instructor(s) if you are ill, have tested positive for COVID-19, or were exposed to an individual who has tested positive for COVID-19 and they will report the information to the Tri-C Compliance & Risk Management team and you may be contacted for follow-up information.
• Wear a mask or face covering at all times, including, but not limited to: upon entering and exiting any Tri-C facility, in class, and in all common areas.
• Maintain a distance of at least six feet between yourself and others at all times and if you must pass near an individual do it quickly and do not linger.
• Provide the College with relevant information about your current health status and participate in any required on-site checks (e.g., temperature checks, current contact information, symptom profile, etc.).
• Use only designated areas of Tri-C facilities, including entrances and exits. Sign in and out of Tri-C facilities as directed.
The general guidelines listed above do not encompass all coronavirus-related guidance. These guidelines are subject to change at the discretion of the College and under the direction of public health authorities. Students who fail to adhere to this guidance may be subject to disciplinary action under the College’s Student Code of Conduct and the Student Judicial Code.

Outcomes
Course Outcome(s):
Evaluate the various methods and the purpose behind signal processing in the ultrasound system.

Objective(s):
1. Identify the types of artifacts encountered in diagnostic ultrasound and state their probable causes.
2. Explain the various types of ultrasound mode display forms.
3. Differentiate between the various types of resolution and indicate how to compensate for a decline in resolution.

Course Outcome(s):
Analyze the laws of hemodynamics to its effects on the circulatory system.

Objective(s):
1. Distinguish how fluid, pressure, and resistance are interrelated.
2. Identify the various kinds of flow encountered in circulation.
3. Explain how stenosis affects blood flow.

Course Outcome(s):
Distinguish and differentiate between a normal and abnormal Doppler display.

Objective(s):
1. Differentiate between the various methods of Doppler signal analysis.
2. Describe the basic principles of color flow Doppler.
3. Identify the instrumentation involved in color flow.
4. Determine whether color flow imaging, power Doppler imaging or duplex Doppler imaging is more appropriate in a given situation.
5. Explain the Doppler Effect and describe the interrelationships between the Doppler equation variables.
6. Evaluate Doppler images to provide a determination of the Doppler Effect.
7. Identify the various Doppler artifacts encountered in diagnostic ultrasound and explain probable causes.

Methods of Evaluation:
1. Weekly quizzes
2. Weekly written assignments
3. Comprehensive mid term examination
4. Comprehensive final examination

Course Content Outline:
1. Concepts
   a. Critical thinking
   b. Digital devices
   c. Instrumentation
   d. Artifacts
   e. Bioeffects
   f. Display modes
   g. Resolution
h. Doppler
  i. Hemodynamics

2. Skills
   a. Interpret Doppler signals
   b. Interpret hemodynamic changes
   c. Manipulate machine adjustments for quality images

3. Issues
   a. Benefits
   b. Limitations
   c. Operator dependent
   d. Interpretation results
   e. Atypical studies
   f. Accuracy

Topical Outline
1. Modes of display
   a. Principal Display Modes (A-mode, B-mode, M-mode)
      i. Definition of each mode
      ii. Information displayed on each mode
      iii. Advantages and disadvantages of each mode
   b. Principles of Real-time Image Formation
      i. Relationship between echo amplitude and B-mode display
      ii. Positioning of echoes
      iii. Harmonics
      iv. 3-D and 4-D

2. Resolution
   a. Axial Resolution
      i. Dependence on spatial pulse length/ pulse duration
      ii. Numerical example
      iii. Effect of damping
      iv. Transducer frequency spectrum-relation to pulse duration
      v. Bandwidth
   b. Lateral Resolution
      i. Dependence on beam width
      ii. Frequency
      iii. Transducer size and focal characteristics
      iv. Range
   c. Slice Thickness Resolution (Elevational Resolution)
      i. Dependence on beam width
      ii. Transducer array and focal characteristics
      iii. Frequency
      iv. Lateral and axial resolution relationship
   d. Temporal
      i. Lines
      ii. Frame
      iii. Sector size
      iv. Depth
      v. Foci
      vi. Pulse repetition frequency

3. Hemodynamics
   a. Energy gradient
   b. Effects of viscosity, friction, inertia
   c. Pressure/volume/flow relationships
   d. Velocity
   e. Steady flow
      i. Laminar
      ii. Parabolic
      iii. Disturbed
      iv. Turbulence
1. Eddies
2. Reynold’s number
f. Pulsatile flow
g. Stenosis
  i. Continuity Rule
  ii. Bernoulli Effect
h. Venous resistance
  i. Hydrostatic pressure
  j. Effects of respiration (phasicity)

4. Doppler Physical Principles
   a. Doppler Effect
      i. Principle as related to sampling red blood cell movement
      ii. Doppler equation
         1. Transmitted versus received
         2. Effect of source frequency on shift
         3. Effect of the angle on shift
         4. Effect of reflector velocity
   b. Factors influencing the magnitude of the Doppler shift frequency
      i. Range of the Doppler shift frequency
      ii. Effects of beam angle, transmitted frequency, flow velocity, and flow direction

5. Doppler Instruments
   a. Pulsed wave Doppler
      i. Transducer construction
      ii. Benefits
      iii. Limitations
      iv. Nyquist limit
      v. Range ambiguity
   b. Continuous wave Doppler
      i. Transducer construction
      ii. Benefits
      iii. Limitations
      iv. Uni- and bi-directional units
   c. Instrumentation
      i. Receiver
      ii. Demodulator
      iii. Wall filter for clutter rejection
      iv. Directional devices
   d. Duplex instruments-definition and basic principles
   e. Spectral analysis
      i. Purpose
         1. Direction
         2. Velocity
         3. Duration
         4. Character
         5. Magnitude
      ii. Fast Fourier Transform (FFT)
      iii. Diagnostic measurements (indices-i.e. pulsatility, resistive)

6. Color Flow Imaging
   a. Basic Principles
      i. Sampling methods
      ii. Display of Doppler information
         1. Reflector direction
         2. Average velocity
         3. Velocity variance
      iii. Advantages and limitations
   b. Instrumentation
   c. Methods of signal analysis
i. Fast Fourier Transform
   1. Spectral analysis
   2. Axis
   3. Turbulent vs. Laminar flow
ii. Autocorrelation
iii. Time domain processing
iv. Color field size and frame rate
   1. Ensemble length (packet size, pulse packet)
   2. Line density
   3. Maximum depth
v. Color maps, assignment, or coding
   1. Hue
   2. Saturation
   3. Luminance (significance, brightness, intensity)
vi. Filters
d. Artifacts Associated with Doppler and Color Flow
   i. Instrumentation (Aliasing, Slice Thickness, Reverberation, Mirror Imaging, Ghosting or Flash, Registration, Incident Beam Angle, Bleed and Clutter)
      1. Definitions
      2. Mechanisms of Production
      3. Appearance
7. Power Doppler
   a. Displayed information
   b. Advantages and limitations

Resources


