El Paso Community College
Syllabus
Part II
Official Course Description

SUBJECT AREA	**Principles of Ultrasound Physics**
COURSE RUBRIC AND NUMBER	**DMSO 2351**
COURSE TITLE	**Doppler Physics**
COURSE CREDIT HOURS	**3 3 : 1** **Credits Lec Lab**

I. Catalog Description

Studies Doppler and hemodynamic principles relating to arterial and venous imaging and testing. A grade of "C" or better is required in this course to take the next course. **Prerequisite: DMSO 1242. (3:1). Lab fee.**

II. Course Objectives

Upon satisfactory completion of this course, the student will be able to:

A. Unit I. The Doppler Effect
1. Identify the principal requirements of diagnostic ultrasound to measure velocity and characterize blood flow.
2. Identify the selection ultrasound system controls for the available Doppler modes.
3. Describe how the Doppler Effect result in an apparent shift in frequency.
4. Conduct a Doppler thought experiment utilizing the train and observer analogy.
5. Illustrate the physical interaction that occurs to create the Doppler Effect.
6. Describe how target velocity affects the Doppler shifted frequency.
7. Identify the relationship between the wavelength and the Doppler Effect.
8. Describe the consequences of relative motion and relative shift as it relates to the Doppler Effect.
9. Calculate the relative Doppler shift utilizing the relationship between detected frequency and transmitted frequency.
10. Identify the relationship between velocity and wavelength.
11. Identify the relationship between wavelength and operating frequency.
12. Identify the relationship between wavelength and propagation velocity.
13. Describe the simplified Doppler equation and round-trip effect.
14. Discuss angle cosine relationship to the Doppler shift equation.
15. Describe the Rayleigh scattering paradox.

B. Unit II. Spectral Doppler System Operation
1. Describe the significance of the system block diagram as it relates to the Doppler functionality.
2. Describe the processes involved in Spectral Doppler (pulser, mixing to baseband, quadrature detection, FFT, analog to digital conversion).
3. Discuss wall filter theory as it relates to dynamic range, clutter signals, and wall filter appearance on the Doppler spectrum.
4. Discuss appropriate wall filter settings with certain clinical applications.
5. Identify the effects of operating frequency on wall filter settings.

6. Describe how to recognize when wall filter saturation affects the spectral Doppler display.
7. Discuss the significance of audible Doppler and its role in interpreting the Doppler frequency shift.
8. Contrast the advantages and disadvantages of pulsed wave versus continuous wave Doppler (timing, ambiguity, aliasing).
9. Describe circumstances that limit maximum detectable velocity (depth, frequency).
10. Identify the anatomy of a normal spectral Doppler waveform (envelope, window, morphology).
11. Illustrate the changes observed in waveform morphology from normal to diseased states.
12. Demonstrate the ultrasound system's pulsed wave Doppler instrumentation and settings.
13. Discuss how to recognize and avoid artifactual spectral Doppler waveform morphology.
14. Describe the role of high pulse repetition Doppler and its function.
15. Demonstrate proper pulsed wave Doppler settings based on differing clinical settings.
16. Identify potential sources of angle and error sources affecting the accuracy of pulsed wave Doppler data.
17. Interpret diagnostic pulsed wave Doppler images.

C. Unit III. Color Flow Doppler Principles
1. Identify the capabilities and limitations of color Doppler information.
2. Compare and contrast flow interpretation capabilities between color Doppler and pulsed wave Doppler.
3. Describe the functions, technology, and instrumentation associated with color Doppler.
4. Demonstrate the ultrasound system's color Doppler instrumentation and settings.
5. Discuss temporal considerations of color Doppler.
6. Identify the appropriate guidelines for the application of color gain.
7. Describe system color Doppler controls (scale, priority, persistence, steering frequency, wall filter).
8. Illustrate the appearance of images with proper color Doppler settings.
9. Demonstrate where and how to alter the system's color Doppler settings.
10. Discuss the application of color Doppler aliasing and invert functions.
11. Describe color wall filters and color scale integration.
12. Demonstrate proper color Doppler settings based on differing clinical settings.
13. Determine flow direction based on display information.
14. Analyze the color Doppler steering and vessel angle effects on color Doppler aliasing.
15. Discuss color power Doppler technology relative to color Doppler and its use in specified clinical applications.
16. Interpret diagnostic color Doppler images.

D. Unit IV. Fluid Dynamics
1. Identify principles of fluid dynamics given a class participation exercise.
2. Define terminology associated with fluid dynamics (flow, velocity, pressure, resistance, heat, viscosity, power, work, energy, capacitance, compliance).
3. Identify frequent misconceptions about the difference between velocity and flow.
4. Identify the significance of having a sound understanding of the principles of flow.
5. Describe the effects of resistance changes on flow.
6. Describe the effects of different disease states on velocity and pressure.
7. Explain the concept of flow profiles.
8. Illustrate normal flow profiles files versus abnormal flow profiles.
9. Demonstrate the observable Doppler waveform alterations with changes in resistance.

10. Discuss the difference between capacitance and compliance as it relates to arterial and venous circulation.
11. Illustrate the effects of hydrostatic pressure on arterial and venous circulation.
12. Discuss the effects of circulatory obstructions on fluid dynamics.
13. Analyze diagnostic images that demonstrate the findings associated with fluid dynamic principles.

E. Unit V. Hemodynamics

1. Identify hemodynamics and Poiseuille's Law.
2. Discuss the assumption of the steady state flow.
3. Discuss the assumption of rigid flow conduits.
4. Analyze the effects of vessel elasticity on the capacitance of the aorta.
5. Discuss the impact and role of Poiseuille's Law in predicting the characteristics of blood flow.
6. Explain the pressure volume relationship of a compliant versus a non-compliant vessel.
7. Describe the capacitive component of the venous system.
8. Discuss the assumption of a single flow conduit.
9. Calculate effective resistance of vessels in series, parallel, and combination.
10. Discuss the assumption of conservation of energy and no energy loss to heat.
11. Explain the impact of Bernoulli's equation on calculating pressure gradients.
12. Discuss the assumption of smooth straight vessels.
13. Illustrate the significance of vessel area and resistance to flow.
14. Discuss the assumption of large vessels.
15. Discuss the assumption of Newtonian fluid and blood viscosity.
16. Discuss the assumption of no turbulence and the Reynolds number.

F. Unit VI. Pressure Flow and Resistance of the Cardiovascular System

1. Explain the function of the cardiovascular system.
2. Describe left heart function and its role in overcoming peripheral resistance.
3. Discuss the role of aortic flow and pressure in the arterial system.
4. Discuss the influence of arterial vessel diameter on resistance and flow.
5. Describe the concept of effective resistance in the arterial-venous system.
6. Compare and contrast the arterial-venous small vessel and micro vascular function.
7. Describe the cardiovascular relationship between the right heart and pulmonary system.
8. Explain the significance of the velocity and cross-sectional area relationship.
9. Discuss changes in the pulse pressure across the cardiovascular system.
10. Discuss the pressure decreases associated with decreased pulsatility and capillary flow.
11. Describe the effects of hydrostatic pressure on venous and arterial circulation.
12. Describe the effects of the calf muscle pump and respiration on venous circulation.
13. Discuss venous transmural pressure and the relationship with edema.
14. Contrast methods required to distinguish subcritical disease from hemodynamically significant cardiovascular disease.

G. Unit VII. Assessing Hemodynamics

1. Discuss what types of hemodynamic information can be gleaned from Doppler.
2. Discuss how to interpret Doppler waveform morphology.
3. Illustrate the hemodynamic information that can be revealed with acceleration time measurements.
4. Discuss the hemodynamic significance of spectral broadening.
5. Describe what information the spectral window and envelope reveal about flow.
6. Discuss the hemodynamic significance of flow reversal and phasicity patterns.
7. Illustrate the normal arterial signal components and how disease affects the signal.
8. Discuss how disease alters the peak and mean velocity of blood.

9. Describe the function of Doppler indices in detecting abnormal flow conditions.
10. Identify causes of Doppler bruit, harmonic bruit, and fluttering.

H. Unit VIII. The Transducers, Artifacts, and Bio Effects Associated with Doppler
1. Discuss proper transducer selection for various Doppler applications.
2. Discuss transducer frequency considerations for performing Doppler.
3. Demonstrate transducer manipulation and control specific to the use of Doppler.
4. Demonstrate how to recognize and correct Doppler aliasing artifact.
5. Describe range ambiguity and the resultant scintillation, haze, and herbies appearance.
6. Identify how to recognize and correct spectral mirroring.
7. Discuss causes of spectral and color blossoming.
8. Identify causes and common circumstances of wall filter saturation.
9. Discuss the thermal and cavitational bio effects risks associated with Doppler.

III. Evaluation

A. Methods:

1. Homework and Quizzes – Written homework assignments will be given periodically; late assignments will not be accepted. Additionally, unannounced quizzes will be given during class time to assess comprehension and application of course objectives. Absence during a quiz cannot be made up. A quiz missed or homework not turned in due to an unexcused absence will result in a grade of zero.
2. Unit Examinations – Unit Examinations will be administered at the end of a specified unitor units to assess master of course objectives. All exams are written and consist of multiple choice, true/false, matching, essay, or a combination of the preceding. An exam missed because of an excused absence must be made up on the day that the student returns to class. An exam missed because of an unexcused absence cannot be taken, and the student will receive a grade of zero (0) for that exam.
3. Comprehensive Final Examination – This examination is given to assess your mastery of the course objectives.

B. Grading Scale:

100 - 92 = A
91 - 83 = B
82 - 75 = C
74 - 67 = D
66 - 0 = F

A total final course grade of below C (i.e., less than 75%) is not acceptable for completion of professional (DMSO) courses.

C. Final Grade Determination

Homework and Quizzes	15% toward final grade
Unit Examinations	65% toward final grade
Comprehensive Final Examination	20% toward final grade
TOTAL	100%

D. Remediation

Your progress in the class will be discussed with you periodically to review areas of concern or improvement. You should understand that failure to achieve a combined course average of at least 75% will prevent your continuation in the Ultrasound program; therefore, any problem regarding course content that you are concerned about should be addressed to me as soon as possible.

E. Attendance

Attendance in class is required to best assimilate the lecture and textbook material. Frequent absences are discouraged.

F. Tardiness

You are tardy when you are more than 10 minutes late to class. Consistent tardiness is disruptive to the class, and you may not be allowed into the class should this continue.

IV. Disability Statement (Americans with Disabilities Act [ADA])

EPCC offers a variety of services to persons with documented sensory, mental, physical, or temporary disabling conditions to promote success in classes. If you have a disability and believe you may need services, you are encouraged to contact the Center for Students with Disabilities to discuss your needs with a counselor. All discussions and documentation are kept confidential. Offices located: VV Rm C-112 (831-2426); TM Rm 1400 (831-5808); RG Rm B-201 (831-4198); NWC Rm M-54 (831-8815); and MDP Rm A-125 (831-7024).

V. 6 Drop Rule

Students who began attending Texas public institutions of higher education for the first time during the Fall 2007 semester or later are subject to a 6-Drop limit for all undergraduate classes. Developmental, ESL, Dual Credit and Early College High School classes are exempt from this rule. All students should consult with their instructor before dropping a class. Academic assistance is available. Students are encouraged to see Counseling Services if dropping because exemptions may apply. Refer to the EPCC catalog and website for additional information.