The vascular system carries blood to the various organs of the body. If the vessels of this system become narrowed or clogged, vital organs can be threatened, and death may ensue. X-ray angiography is one of the modalities used to assess the anatomy and function of the vascular system. In most angiographic systems, digital images are acquired, and thus a variety of image analysis packages have been and are being developed for extracting quantitative data from the angiograms to assist in this assessment.

In this lecture, the various aspects of imaging the vascular system with the current x-ray modalities will be presented, and methods of vessel size measurements, blood flow measurements, 3D calculations, and 3D analysis will be discussed. The image intensifier-TV-display system converts the x-ray flux to a visual image at a rate of 30 frames/second. The various components of this system affect the resolution and noise in the angiograms as well as introduce distortions. Subtraction of images acquired before injection from those acquired during the injection yields images in which the non-vascular structures are removed, thereby facilitating visualization as well as quantitative analysis of the vessels. One of the primary measurements performed, both with analog and digital methods, in angiography is size of the vessel in the angiogram. While a variety of techniques have been proposed for measurement of vessel sizes, derivative techniques are commonly used in clinical systems. Because of the rapid acquisition of the images, the flow of the contrast material through the vessel can be monitored. Time-density as well as distance-density techniques have been proposed for measurement of blood flow rates. For comparison of vessel size and blood flow over time, the magnification and orientiation of the vessels must be known. Thus, methods have been developed to determine the positions of the vessels in the vascular tree relative to the focal spot for biplane and multiple projection systems. With the advent of helical scanning, computed tomography angiography (CTA) is being used more frequently and is replacing standard angiography for diagnosis in some cases. Methods for extracting and analyzing vessel in CTA data sets to facilitate vascular evaluation have been developed.

Educational Objectives:
1) Knowledge of the type of information one can obtain from angiographic images
2) Knowledge of the components of the II-TV system
3) Appreciation of the effect of these components on resolution, contrast, and distortions in angiographic images.
4) Understanding of DSA
5) Understanding of techniques of measurement of vessel sizes
6) Understanding of techniques for vessel tracking
7) Understanding of methods for blood flow measurements
8) Introduction to methods for determination of 3D vascular trees from angiograms
9) Introduction to methods for computer tomography angiography