Problem 1

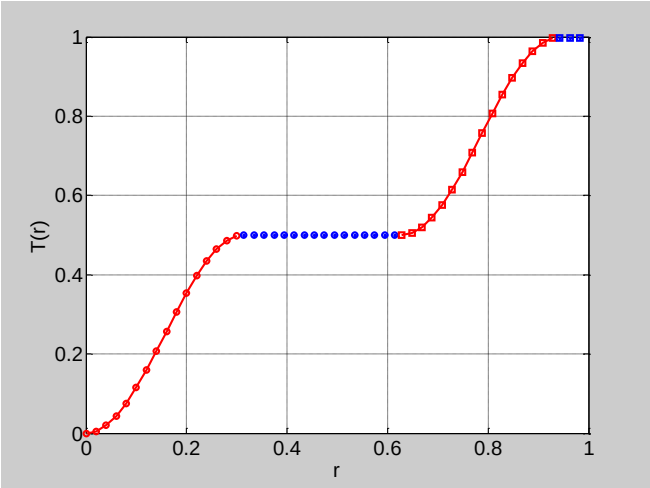
1.1

$10r = n\pi \rightarrow r = n\pi/10$, n=0,1,2,3

$$T(r) = \int_0^r \text{asin}(10w)\, dw = \frac{-a \cdot \cos(10w)}{10} = \frac{-a \cdot \cos(10w)}{10} + \frac{a}{10}$$

$$T(r) = \int_{2\pi/10}^r \text{asin}(10w)\, dw = \frac{-a \cdot \cos(10w)}{10} = \frac{-a \cdot \cos(10w)}{10} + \frac{a}{10}$$

$$For\ T(1) = 1 \rightarrow a = 20/8$$



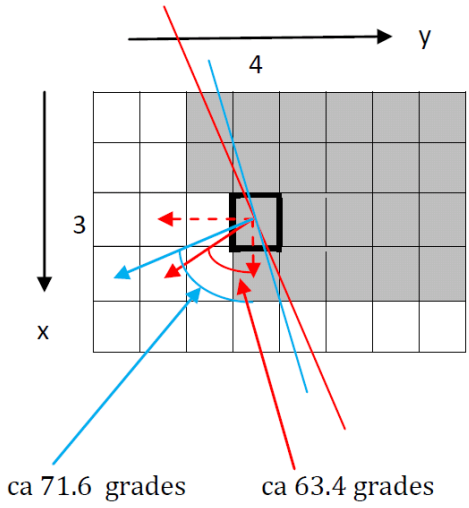
1.2

Prewitt gradient = [dx dy] = [1 -2], marked as →

Prewitt's magnitude = sqrt(5)

Sobel gradient = [dx dy] = [1 -3], marked as →

Sobel magnitude = sqrt(10)



Problem 2: 1-b, 2-g, 3-i, 4-j, 5-d
Problem 3: 3.1 1-b, 2-d, 3-a, 4-c
3.2 (a) preprocessing : lowpass filter to remove noise
(b) convert the problem to 1D by for example using radius/angle coordinates evaluated with a coordinate center in the center of the object (heart)
(c) the cost matrix may be based on the gradient image (gradient magnitude). The high gradient corresponds to the object boundary so the high gradient magnitude should correspond to a low cost (when using Dynamic Programming with minimum total cost as th objective function).

Problem 4: see teh Lecture Notes on Hough Transform, applied to the 1st quadrant only
Problem 5:
Take for ex. rectangular kernel, let hs=1 pixel (spatial domain)
and hr = 1 gray scale value (range domain)

Mean shift mode detection: The 3-D histogram of the image gives the following points (modes)
(157, 7, 78) - based on ten (10) pixels
(245, 174, 1) - based on ten (10) pixels
(255, 208, 0) – based on five (5) pixels
Mean shift discontinuity preserving filtering:
All the pixels will converge directly at the first step to the histogram modes
All pixels will value (157,7,78) will converge to (157,7,58) and so on

Determine the clusters:
All pixels having value (157,7,78) are close (actually equal) to the mode (157,7,78) and spatially also close (=1 pixel) to each other --> Pixels with value (157, 7, 78) will form a cluster. Similarly for the other pixels.
Result: The three clusters:
C1 = all pixels having value (157, 7, 78),
C2 = all pixels having value (245, 174, 1)
C3 = all pixels having value (255, 208, 0)

Problem 6 (se = sensitivity, sp= specificity, err = error rate, T = threshold value)
T=0..0.2, se = 2*T sp = 1
err = ½ *[(1-se)+(1- sp)] = (1-2T)/2 , min for T=0.2 ---> err= 0.3
--
T = 0.2 ..0.4, se = 2T sp = (1.6 - 5(T-0.2)(T-0.2))/1.6 = 1 – (25/8)(T-0.2)(T-02)
err = ½[(1-2T) + (25/8)(T-0.2)(T-0.2)]
T = 0.2 --> err = 0.3
T= 0.4 --> err = 0.1625
--
T = 0.4 ..0.6
we can see that specificity will decrease (Type II error will increase) while sensitivity is constant so the total error will increase.
--
T= 0.6 ..0.9 --> the same as above, the total error will increase
--
T=0.9 .. 1
se = 2(0.4 + (T-0.9) sp = 12.5(1 - T)(1-T)
err = - 0.3 + T - 5(1-T)(1-T)/3.2

T= 0.9 --> err = 0.5844
T = 1 --> err = 0.5
---> min error for T=0.4, err = 0.1625