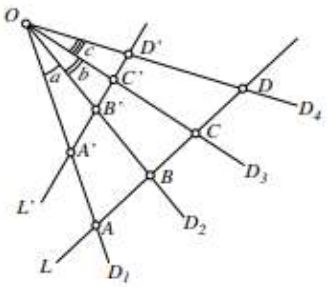
ELL793: Computer Vision **Total Time: 120min**

Major (January, 2021) **Total Marks: [35]**

NOTE: This paper contains seven questions, attempt all. Assume if any missing data. (7Q x 5/Q=35)

Q1. a. Describe the epipolar geometry of a stereo camera and illustrate various constraints in regards to computer vision. [3]

b. The cross-ratio of four collinear points A, B, C, and D is defined as: {A, B; C, D} = (CA/CB).(DB/DA). Use the result of the previous problem to show that: {A, B; C, D} = {sin(a + b) sin(b + c)} / {sin(a + b + c) sin b }, where the angles a, b, and c are defined as below. [1]



c. Use this result to define the cross-ratio of four coplanar lines passing through the same point. Hint: Consider the lines L and L′ in the diagram. [1]

Q2. a. Prove that If we apply convolution filter F x F in (N+2p) x (N+2p) input matrix with padding, then we will get output matrix dimension (N+2p-F+1) x (N+2p-F+1). What is the change if we introduce stride s also? [2]

b. Calculate the output sizes for each of the following layers if input is 32x32pixels: [1]

LeNet CNN Structure

# Layer	Layer Type	Feature Maps	Kernel/Filter or Units
Input	Image	-	-
C1	Convolution	6	5x5
S2	Sub Sampling	6	2x2
C3	Convolution	16	5x5
S4	Sub Sampling	16	2x2
C5	Convolution	120	5x5

c. What are Dropout and Batch Normalization? Explain what are the new techniques used in Alexnet and VGG. Clearly explain the three techniques with the help of a neat block diagram. [2]

Q3. a. What is Deep Learning? Why is it required in Computer vision applications? [1]

b. Is it always better than hand–crafted features in Conventional Neural Networks? [1]

c. What Are the Different Layers on CNN? [1]

d. What Are Vanishing and Exploding Gradients? [1]

e. What Is the Role of Activation Functions in a Neural Network? Compare activation functions Relu and Sigmoid. [1]

Q4. a. Derive multi-task loss for Fast-RCNN. Clearly explain each component of the loss and how they are combined. [3]

b. Explain back propagation through RoI pooling layers. [2]

Q5. a. Discuss SSD training objective using MultiBox objective. [3]

b. What are the limitations of YOLO? Compare YOLO with Overfeat, SSD, Fast and Faster RCNN and summarise your discussion with a table. [2]

Q6. a. What is the difference between DoG and Log, where is each used? Obtain the expression of an input image f(x, y) convolved with LoG kernel. [2]

b. Explain why Zero crossings of this convolved image are required, which type of filter will you need to smooth the image? [1]

c. What is Feature Pyramid Network? How do you explain FPN for Region Proposal Network? [2]

Q7. a. Explain the problems with deeper nets which led to the development of Resnets? [1]

b. Explain with diagram the architecture of ResNets and InceptionNets.[3]

c. Explain Key advantages of Skip Connections? Why does it work? [1]

All the Best!!!