**BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI**

Department of Computer Science and Information Systems

**II SEMESTER 2022-2023**

**BITS F453 – Computational Learning Theory**

17th March 2023 Mid-semester Exam (closed book) Weightage: 30%

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1. What is inductive bias? What role it plays in ERM learning paradigm? Given a learning problem, how do we restrict the search space using inductive bias?

   [4]

2. Is finiteness of a Hypothesis class H, a necessary and sufficient condition for learnability? Can infinite hypothesis classes be learnable? If yes, how can we show that.

   [4]

3. Between the two – learnability with uniform convergence and non-uniform learnability, which one leads to more efficient learning? Justify your answer using the concept of sample complexity.

   [4]

4. Visually illustrate that the VC dimension of the following infinite hypothesis classes is infinite:
   *a.* Family of sine functions, $\sin(\omega t)$, $\omega \in \mathcal{R}$
   b. Convex Polygons

   [2+2]

5. Define Growth Functions & break points and give one example of each. Relate them to VC Dimension?

   [4]

6. State the conditions under which a learning problem $(\mathcal{H};\mathcal{Z};l)$, where $\mathcal{H}$ is a hypothesis class, $\mathcal{Z}$ is a set of examples, and a loss function $l: \mathcal{H} x \mathcal{Z} \rightarrow \mathcal{R}_+$, is called a convex learning problem.
   Show that linear regression with a squared loss function is a convex learning problem.

   [2+4]

7. Show that $f(x)=x^2$ is:
   a. not $\rho$-Lipschitz over $R$ for any $\rho$.
   b. $2\rho/3$-Lipschitz over the set $C = \left\{x: |x| \le \frac{\rho}{3}\right\}$.

   [2+2]

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