

# NEURALPHY

**Implementing Physics through Neural Networks**

Based On

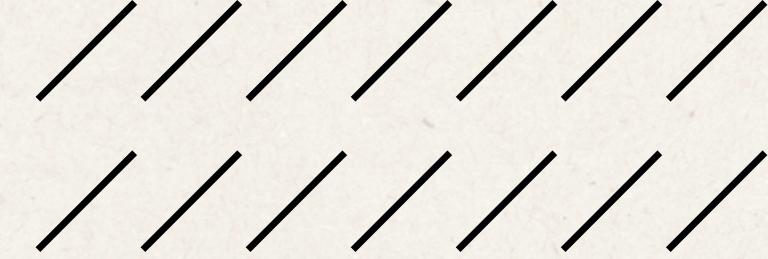
**PINNs: Physics Informed Neural Networks**

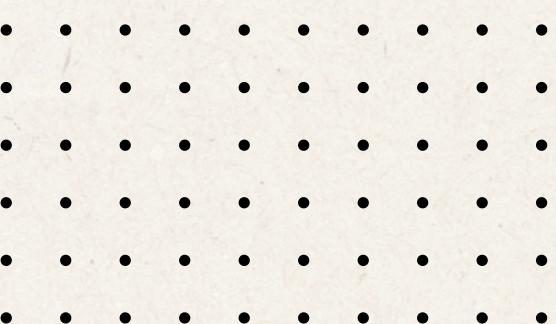
Mentors:

- Parnika Mittal (230736)
- Aayushman Kumar (230029)
- Ikrima Badr Shamim Ahmed (230482)



# WHAT ARE PINNs ?

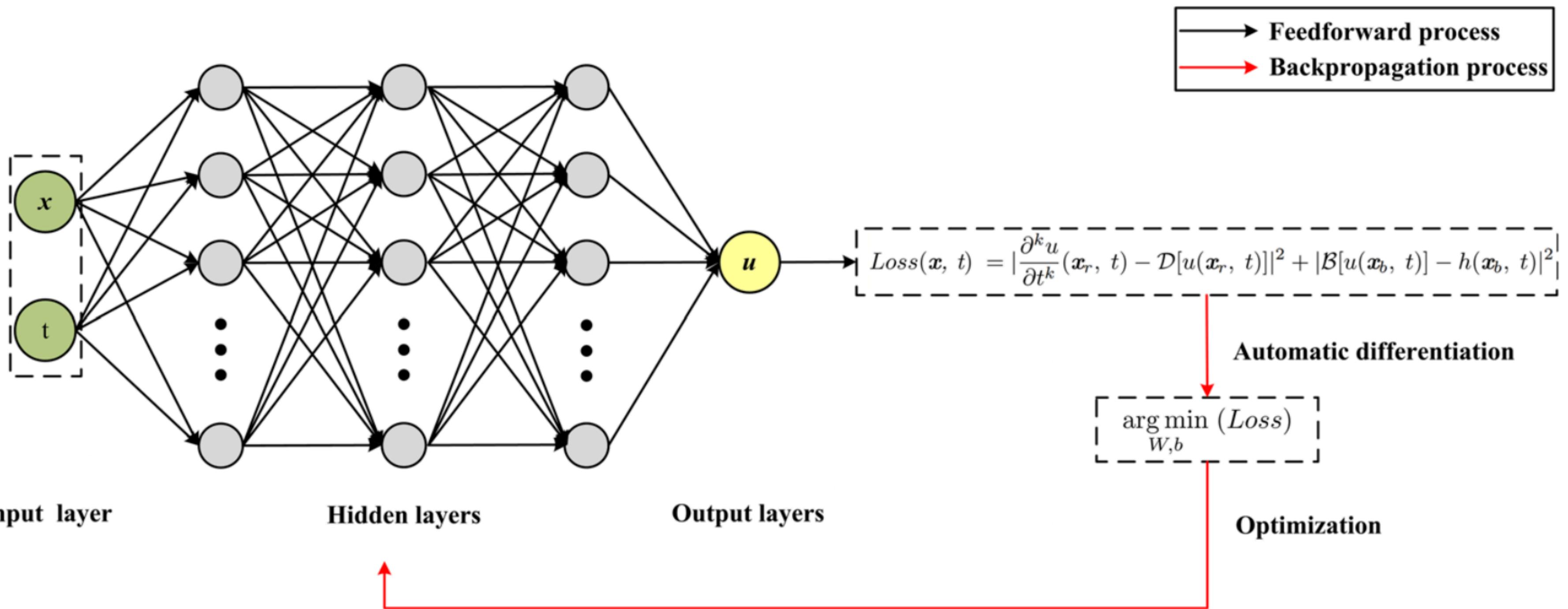
- 
- PINNs are a type of neural network that can be used to solve differential equations, which are used to model physical systems in fields such as physics, engineering, and materials science.
  - PINNs have shown to be more efficient and accurate than traditional methods, and can handle complex geometries and incomplete or noisy data.



# INTRODUCTION TO PINNs.

- PINNs use a neural network to learn the relationship between inputs and outputs of a physical system, and then enforce the governing differential equation as a constraint on the network's output.
- This allows the network to predict the behavior of the system under different conditions, while ensuring that the predictions are physically consistent.
- PINNs use a neural network to learn the relationship between inputs and outputs of a physical system, and then enforce the governing differential equation as a constraint on the network's output.
- This allows the network to predict the behavior of the system under different conditions, while ensuring that the predictions are physically consistent.
- PINNs have several advantages over traditional methods, including the ability to handle incomplete or noisy data, the ability to handle complex geometries, and the ability to scale to high-dimensional problems.

# PINN ARCHITECTURE

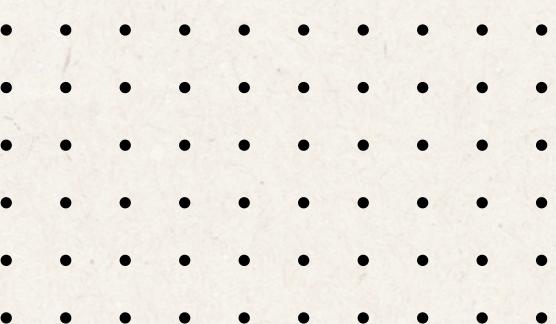


# PINN ARCHITECTURE.

- A PINN typically consists of an input layer, an output layer, several hidden layers, and a physics-informed layer.
- The input layer receives the input parameters, such as time or space coordinates, and the output layer provides the predicted solution.
- The hidden layers perform nonlinear transformations on the input to generate a high-dimensional representation of the input.
- The physics-informed layer enforces the differential equation constraint on the network's output, and can include additional parameters to be learned by the network.

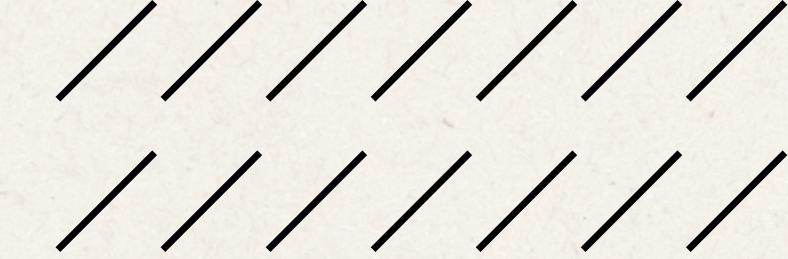
# PINN APPLICATIONS.

- Solving partial differential equations for fluid dynamics and turbulence modeling.
- Modeling and predicting the behavior of materials under stress and strain.
- Designing and optimizing complex mechanical systems, such as engines or aircraft components.
- Predicting and controlling the behavior of complex chemical reactions.
- Estimating the parameters of physical systems, such as the diffusion coefficient in a reaction-diffusion equation.

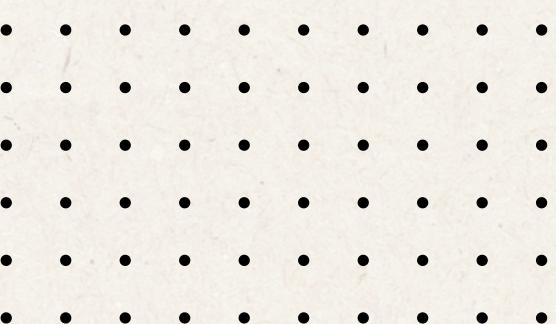




# LEARNING OBJECTIVES.

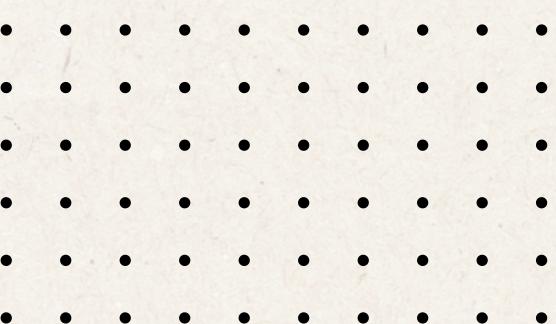


- Understand what Physics Informed Neural Networks are and how they work.
- Recognize the advantages and limitations of PINNs compared to traditional methods.
- Explain the architecture and training process of a PINN.
- Identify real-world applications of PINNs in physics, engineering, and other fields.
- Appreciate the potential impact of PINNs on solving complex physical problems.

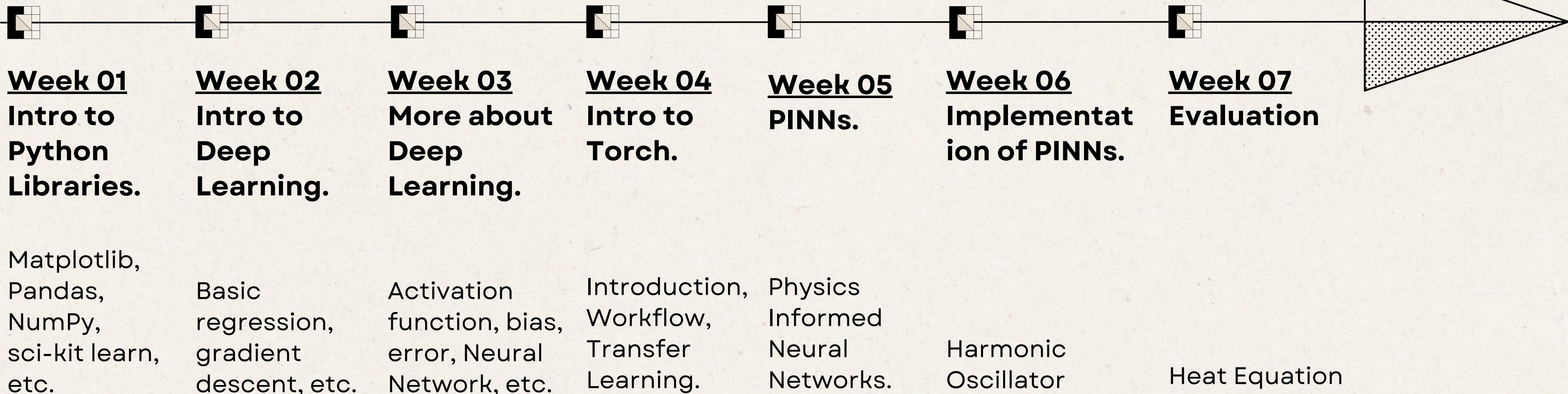


# PROJECT LOGISTICS.

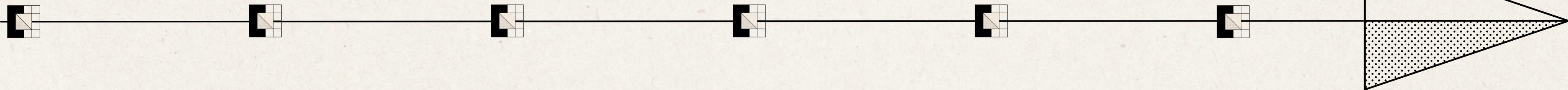
- This project will run for 8 weeks.
- We are going to recruit around **~30** mentees.
- There will be a test for recruitment for which syllabus will be **Basic Python and Linear Algebra**.
- This project will cover theory as well as application of neural networks on physical systems.
- The time commitment will be around **8-10 hours per week**.



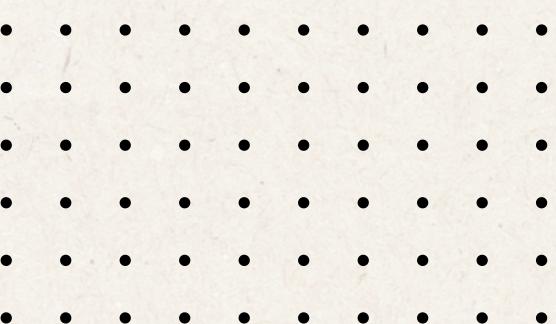
# PROJECT TIMELINE



# ASSIGNMENTS



<u>Assignment</u> <b>01</b>	<u>Assignment</u> <b>02</b>	<u>Assignment</u> <b>03</b>	<u>Assignment</u> <b>04</b>	<u>Assignment</u> <b>05</b>	<u>Assignment</u> <b>06</b>
Based On Python and Python Libraries.	Machine Learning (Regression)	Neural Networks and Linear Algebra	Torch (Code Completion of Half Baked Colab File)	PINN - Differential Equations and Mathematics for Physics.	Final Evaluation: Heat equation using torch



# THANK YOU!

## CONTACT DETAILS

**Parnika Mittal**

+91 81263 34477

**Aayushman Kumar**

+91 81088 04449

**Ikrima Badr Shamim Ahmed**

+91 80978 44011

[mparnika23@iitk.ac.in](mailto:mparnika23@iitk.ac.in)

[aayushmank23@iitk.ac.in](mailto:aayushmank23@iitk.ac.in)

[ikrimab23@iitk.ac.in](mailto:ikrimab23@iitk.ac.in)