ROBOTICS CLUB

SCIENCE AND TECHNOLOGY COUNCIL
IIT KANPUR

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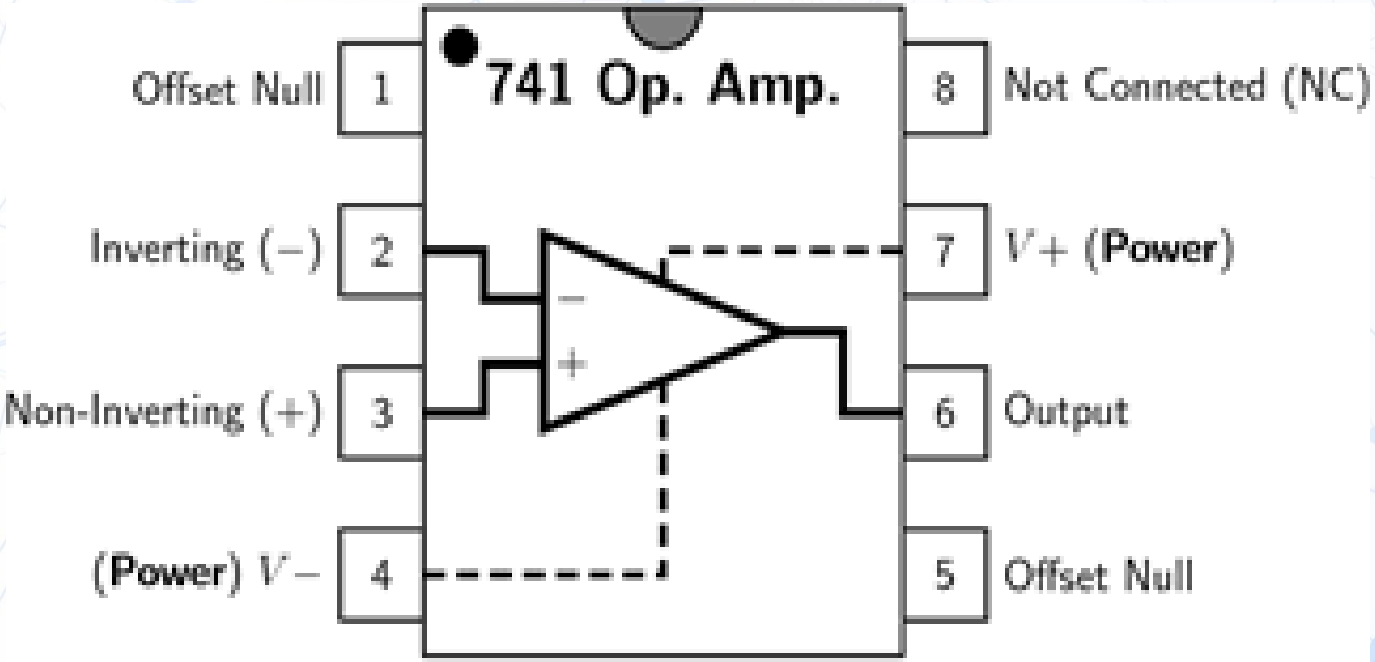
Winter Workshop

Python Programming

Courtesy: Professor Vipul Arora (EE698V Instructor)

“Black-box” Approach of Learning

Op Amp



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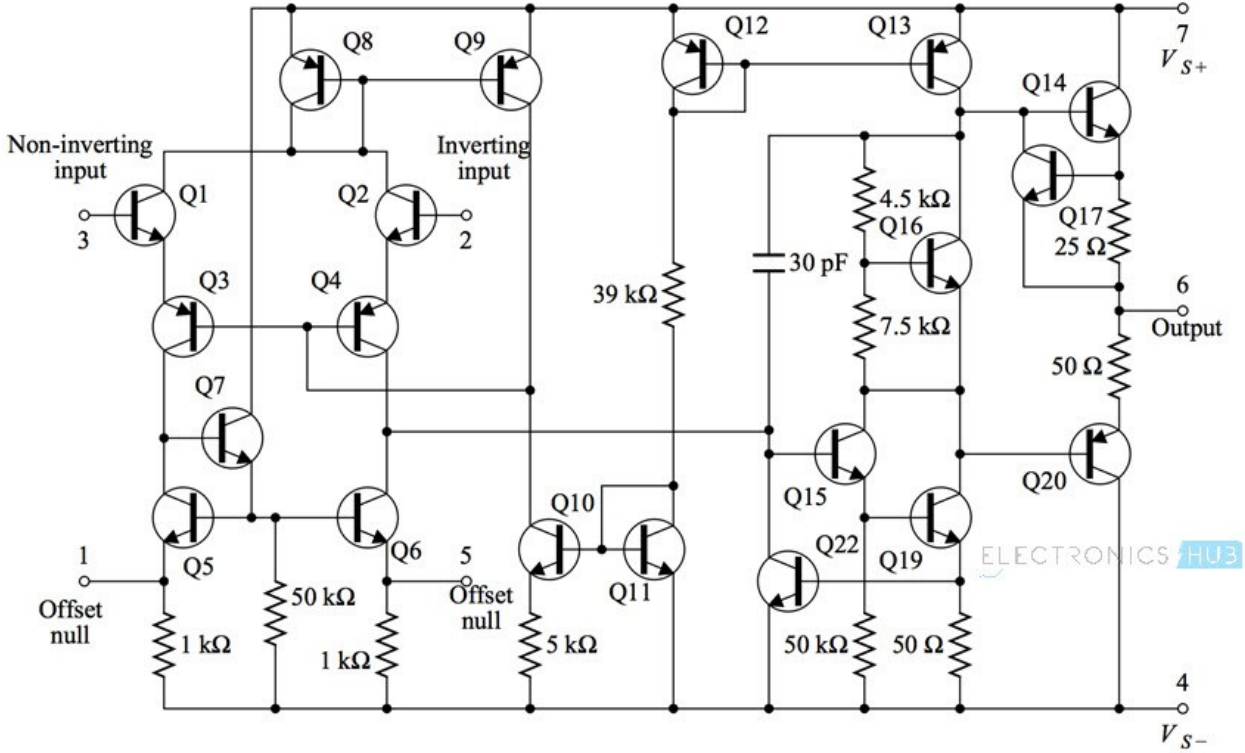

Internal Circutry of 741 Op-Amp IC

You already know more than 50% of Python!!!

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Programming Languages consist of 2 main components-

1. Logic
2. Syntax

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What language do you think in?

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In Programming, if you can think in C, you can code in any language.

(That's precisely why we are taught C in ESC101)

2. Syntax?

Extremely Intuitive!

Tools we will be using:

Jupyter Notebooks (Python3)
Google Colab Python Notebooks

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Libraries - Benefiting from Other people's Social Work:

Numpy
Matplotlib
cv2
keras
pytorch
scikitlearn

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Q. How can we create a 3x3 array of zeros in C?

Using numpy

```
In [12]: A = np.zeros((4,4))
         print(A)
```

```
[[0. 0. 0. 0.]
 [0. 0. 0. 0.]
 [0. 0. 0. 0.]
 [0. 0. 0. 0.]]
```

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Task: Create a 5x2 array of ones

Hint: Python is super-intuitive

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You'll find a function for all tasks in Python!

But you need to learn "The Art of Googling!"

Principal Component Analysis in Python

Principal Component Analysis

Principal component analysis (**PCA**) is a mathematical procedure that transforms a number of (possibly) correlated variables into a (smaller) number of uncorrelated variables called **principal components**. ... **Principal components analysis** is similar to another multivariate procedure called Factor **Analysis**.

For learning any ML algorithm, you need to-

Appreciate the Algorithm

Understand the underlying Mathematics

Implement the Algorithm

Example:
What all data do I have about you?

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Name
Roll Number
Department
Gender
Specific Interests
Parent Hall

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This is a lot of data and there’s redundancy.
I want to make my life easy!

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What I want?

2 new sets of information-

Dim1

Dim2

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Principal Component Analysis

- Given data samples $\boldsymbol{s}_n \in \mathbb{R}^D$
- Normalize: $\boldsymbol{x}_n = \boldsymbol{s}_n - \mathbb{E}[\boldsymbol{s}]; \quad \mathbb{E}[\boldsymbol{s}] = \frac{1}{N}\sum_{n=1}^{N} \boldsymbol{s}_n$
- Obtain variance matrix $S = \frac{1}{N}\sum_{n=1}^{N} \boldsymbol{x}_n \boldsymbol{x}_n^T$
- Eigen value decomposition of S to get $\lambda_i, \boldsymbol{u}_i; i = 1, \dots, D$ with λ_i in decreasing order
- Choose first M eigen vectors as the principal axes
- $\tilde{\boldsymbol{x}}_n = \sum_{i=1}^{M} (\boldsymbol{x}_n^T \boldsymbol{u}_i)\boldsymbol{u}_i$

Implementation in Jupyter Notebooks using numpy and matplotlib

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