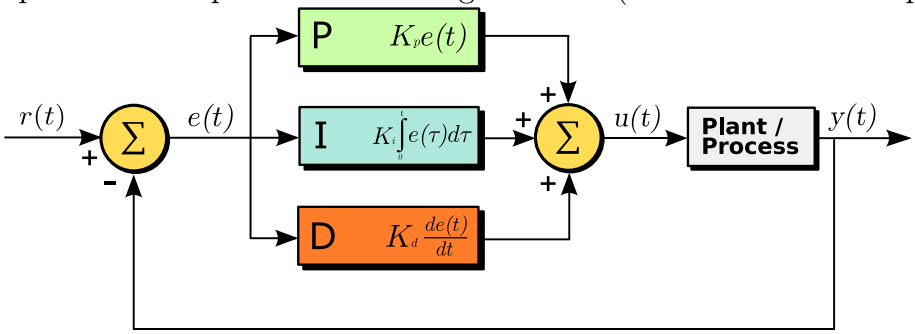
EE774 - Lab 8

For all the problems below, please adhere to the following:

- Submit both the Python code as well as the PNG plot for each of these exercises in a single Zip file

1. (10 points) In this exercise, you will make a 3D plot using matplotlib.
   - To create a 2D grid, use np.linspace to create two arrays, x and y ranging between -3 and 3.
   - Create matrices that have the appropriate x and y values on a grid, using the `np.meshgrid` function. Read the documentation on meshgrid to see how it works.
   - Using the meshgrid generated, evaluate $e^{-x^2-y^2}$.
   - Finally, use the add subplot feature to generate a 3D plot. See the **mplot3d documentation** for details.

2. (10 points) A PID controller is one which can be used to "control" a plant to track a particular set point. Refer the figure below (borrowed from Wikipedia):



   Here, the aim is to design K_p (proportional), K_i (integral) and K_d (derivative) controllers to make the plant output $y(t)$ track the set point $r(t)$. As an example, $r(t)$ can be the desired temperature, while the "plant" can be an air conditoner whose cooling has to be controlled to ensure that the room temperature $y(t)$ is close to $r(t)$. In other words, the error $e(t)$ has to go to zero. For the following, plot $y(t)$ and $r(t)$ vs. t.
   - Consider the plant $1/s$. For this, set up the differential equations governing therelationship between $r(t)$ and $y(t)$. Solve the differential equation numerically using `solve_ivp` for $K_p = 1$, $K_i = 0$, $K_d = 0$. Repeat by setting $K_i = 1$, $K_p = 0$, $K_d = 0$ and, finally with only K_d. What do you observe?
   - Repeat for the plant $1/(s^2 + 10s + 20)$.