Assignment 10: Differential Equations

Date Due: May 3, 2023 Instructor: Trani

Problem 1

Asphalt is a very important material to civil engineers because it is used in paving operations of roads and airports. The fabrication of asphalt requires the material to be heated to allow better mixing. The contractor uses a large rotating fan to cool the asphalt during the pavement construction process. The first order differential equation (dT/dt) that estimates the rate of change of temperature of concrete as a function of time is:

$$\frac{dT}{dt} = -H(T - T_a) - sin(\frac{t}{2})(\frac{T - T_a}{12})$$

Where:

$\frac{dT}{dt}$ is the rate of change of asphalt temperature with time (degrees C./minute)

T is the asphalt temperature (degrees C.)

T_a is the ambient temperature (degrees C.)

H is a constant of proportionality (1/minutes)

t is the time of the cooling process (minutes)

Task 1

Create a Simulink model to solve the problem. The values of T_a, H are 15 degrees C. and 0.08 (1/minute), respectively. The initial temperature of the asphalt is 150 degrees Celsius. Show a screen capture of the Simulink model.

Task 2

Test the Simulink model created in Task 1 simulating the temperature profile of the asphalt material for 90 minutes after placement on the road. Show your Simulink plot of temperature versus time as a screen capture.

Task 3

Plot the asphalt temperature as a function of time using the model created in Task 2 in **Matlab** by exporting the answers of the Simulink model to Matlab.

Task 4

Find the time when the asphalt is within 3% of the ambient temperature for the first time.

Problem 2

Task 1

Solve the differential equation of Problem 1 using the Matlab Ordinary Differential Equation solver ODE45).

Task 2

Compare the solutions of Task 1 in Problem 1 and the solution obtained in Task 3 of Problem 1