**Description of Assessment Task and Purpose:**

**Question 1**

1. Consider the oil tank below that has a constant cross-sectional with a diameter of 1m. The tank is designed to feed the turbocharger of a large diesel engine in the case of a power black-out. The tank must provide oil to the turbocharger to prevent damage during its emergency shut-down which takes approximately 10 seconds. In order to maintain oil pressure to the turbocharger the oil must not drop below a height of 10cm during these 10 seconds.

Diagram

Description automatically generated

1. Form a differential equation that represents the system. **(5 marks)**
2. Solve the differential equation given that  at . **(10 marks)**

(c) Determine the time it will take for the tank to reach the minimum level of 10cm if the initial height of oil, , is 50cm and , plot a graph of  against  and hence decide if the tank is suitable. **(5 marks)**

**Question 2**

A car suspension system consisting of a spring and viscous damper carries a mass of 250kg. The damping coefficient, c, of the damper is 110Ns/m and the spring stiffness, k, is 600 N/m. The road surface subjects the system to a sinusoidal force of 10N at an angular frequency of 2 rad/s.

1. Form a differential equation that represents the system. **(5 marks)**

(b) Solve the homogeneous equation and **plot** a graph of against in order to show the transient response of the system if the initial displacement, m and  at . **(10 marks)**

(c) Solve the non-homogeneous equation and **plot** graphs of against in order to show the steady-state and overall response of the system. **(10 marks)**

(d) Describe the overall response of the suspension system making reference to your solution. **(5 marks)**