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**MEEM 5812: Automotive Control Systems**

**Spring, 2023**

**Project – 3**

**Optimal Idle Speed Control   
of a Spark Ignition Engine**

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**By**

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1. What are the equilibrium states for the idle speed control system?

Ans. The equilibrium states for the idle speed control system are as follows:

1. Throttle input (Ua) = 0.06213
2. Intake Manifold Pressure (Pi) = 38900

2. What is the final linearized plant model?

Ans. The final linearized plant model is:

X = [0.2168 0.02329 0 0;

-140 -2.1911 0 0;

-1 0 0 0;

0 0 0 0]

Y = [0 15;

1.4e6 0;

0 0;

0 -1]

3. What happens when the state weighting matrix is increased by a factor of 2. What happens to the state trajectories? What happens to the control trajectories?

Ans. When the state weighting matrix is increased by a factor of 2, we observe the following effects:

a) The Spark timing changes by a minimal amount from the range of [-19.5 to -20.07] to

[-19.9 to -20.05] that is, the spark timing decreases

b) The throttle input remains the same, that is there is no effect

c) Engine speed increases from 605 to 620.

4. What happens when the control weighting matrix is increased by a factor of 10. What happens to the state trajectories? What happens to the control trajectories?

Ans. When the control weighting matrix is increased by a factor of 10, following changes are observed:

a) The Spark timing changes drastically and becomes unstable and gets out of range.

b) There are no changes in observed in throttle input.

c) Engine speed range changes drastically in the range of 850 to 450