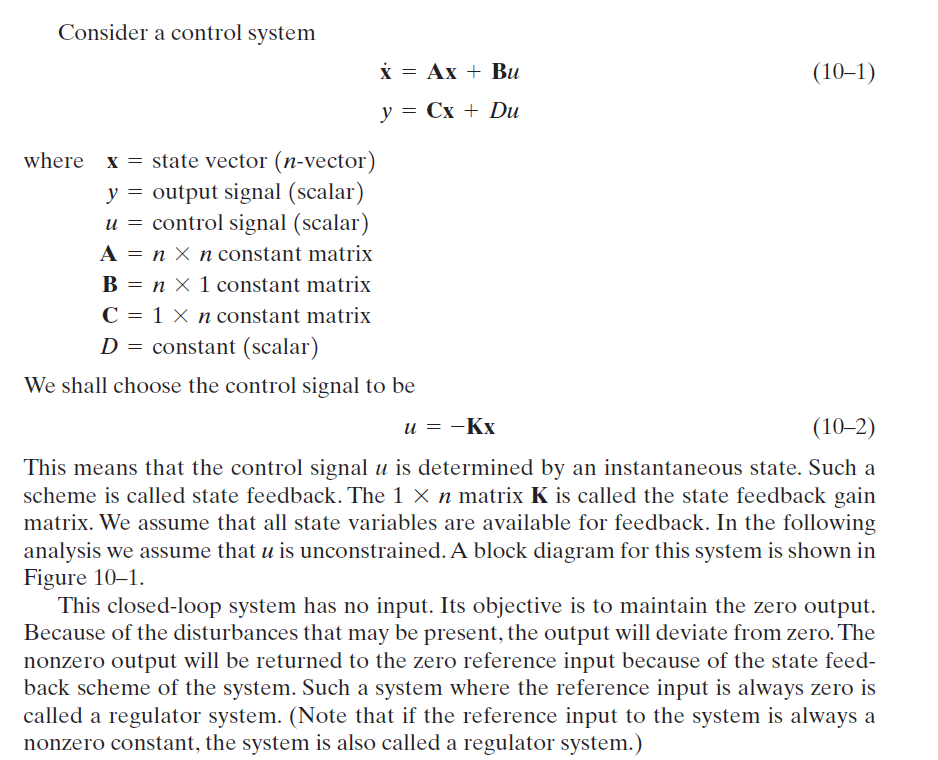
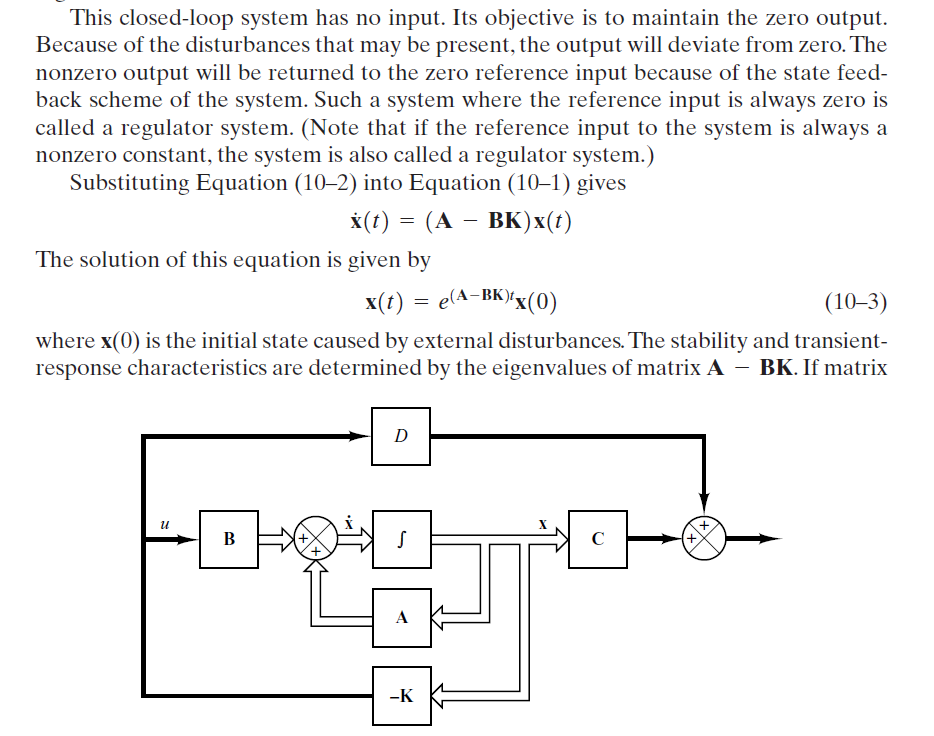
**CONTENT**

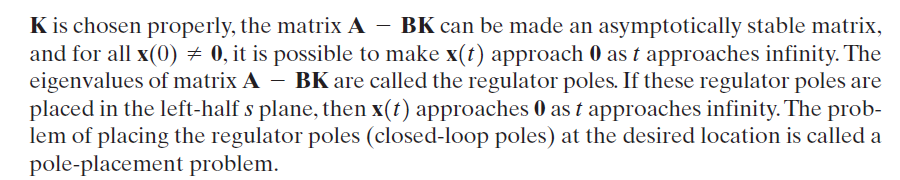
|  |  |  |
| --- | --- | --- |
| **S.No.** | **Content** | **Page No.** |
| 1 | System and Input | 2 |
| 2 | LQR | 4 |
| 3 | Mobile Robots - Kinematics | 11 |
| 4 | Euler Lagrange Equation | 13 |
| 5 | Lagrange Mechanics | 17 |
| 6 | Lagrange Equation with Mechanics | 21 |
| 7 | Motor Model | 29 |

**SYSTEM and INPUT**

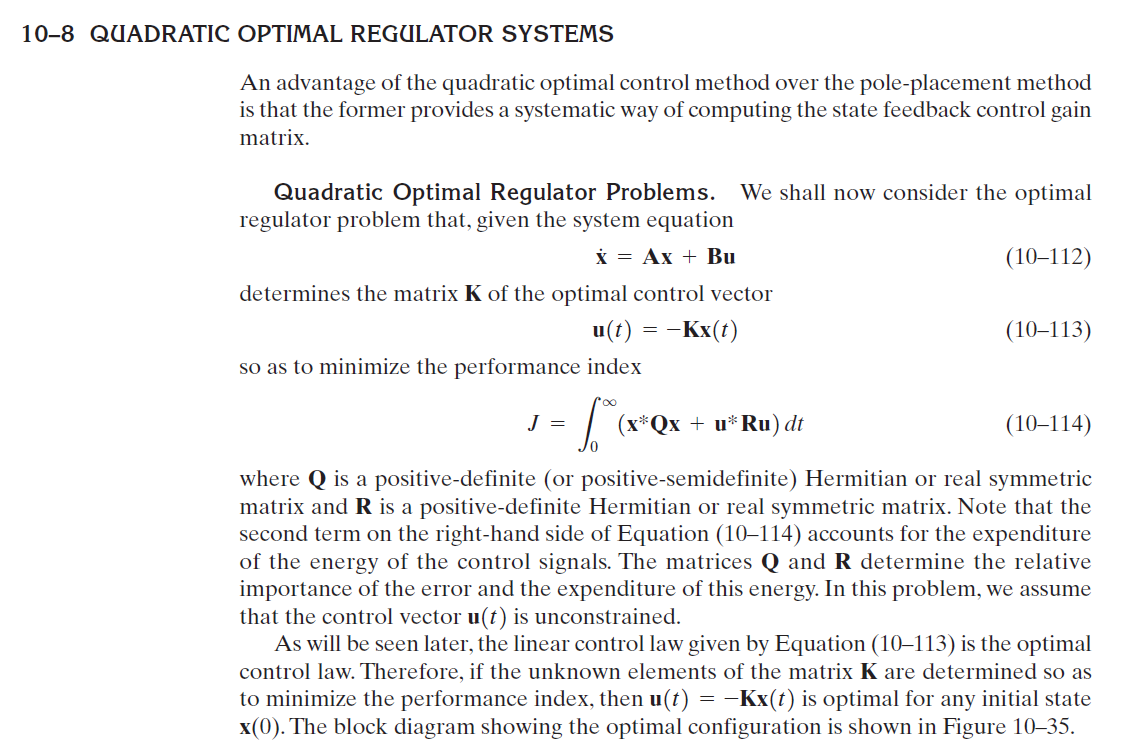
(Ogata)

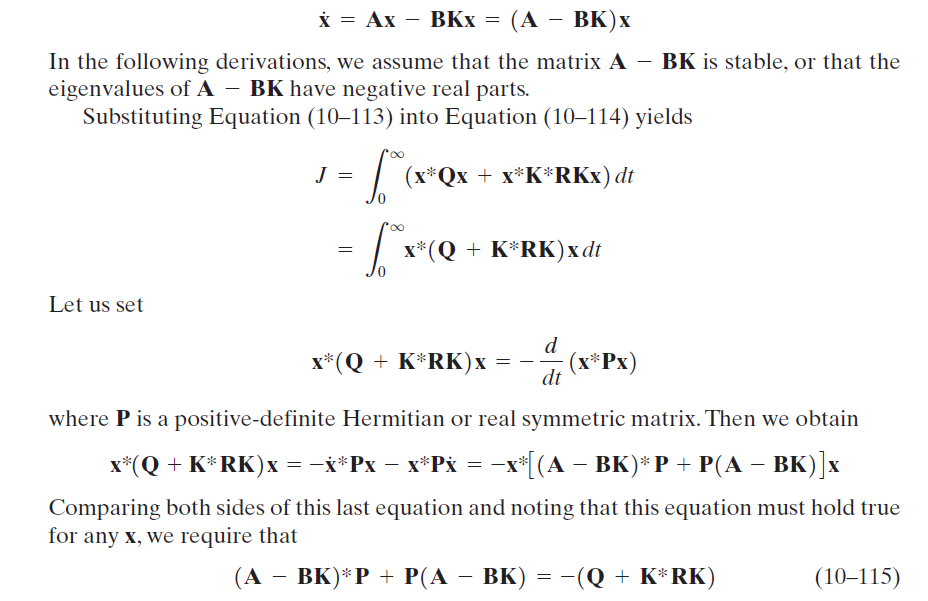


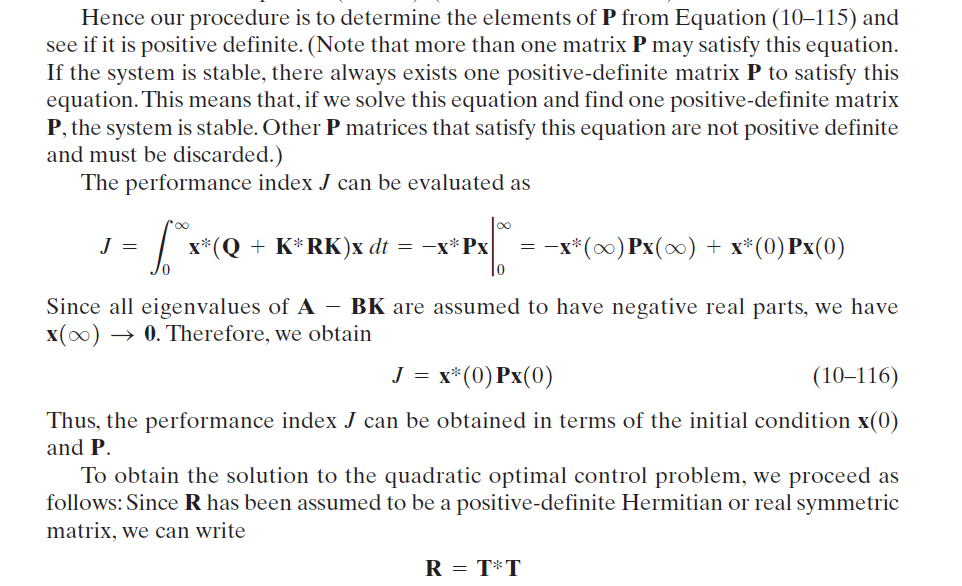


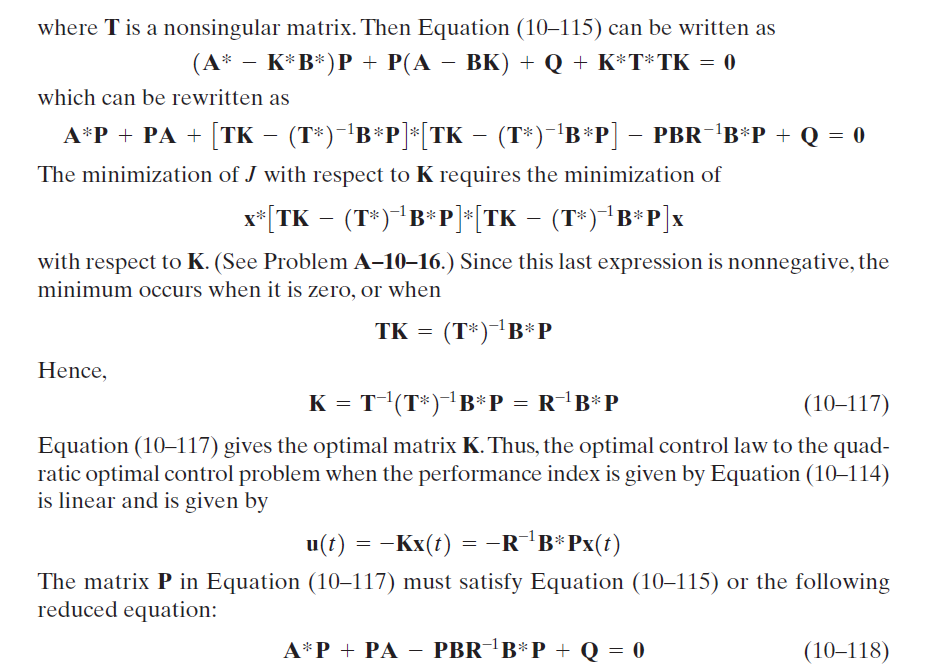


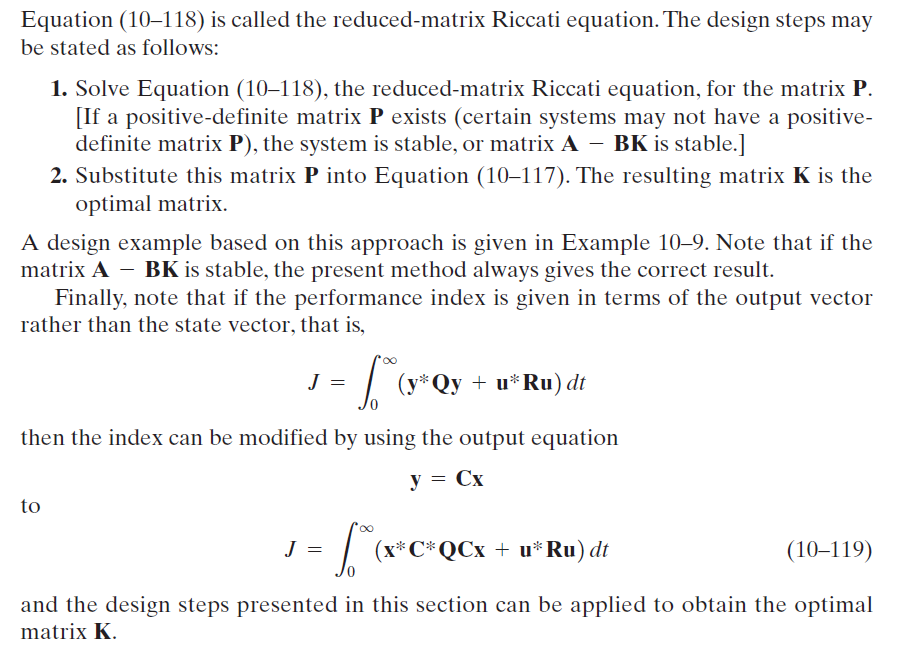
**LQR**



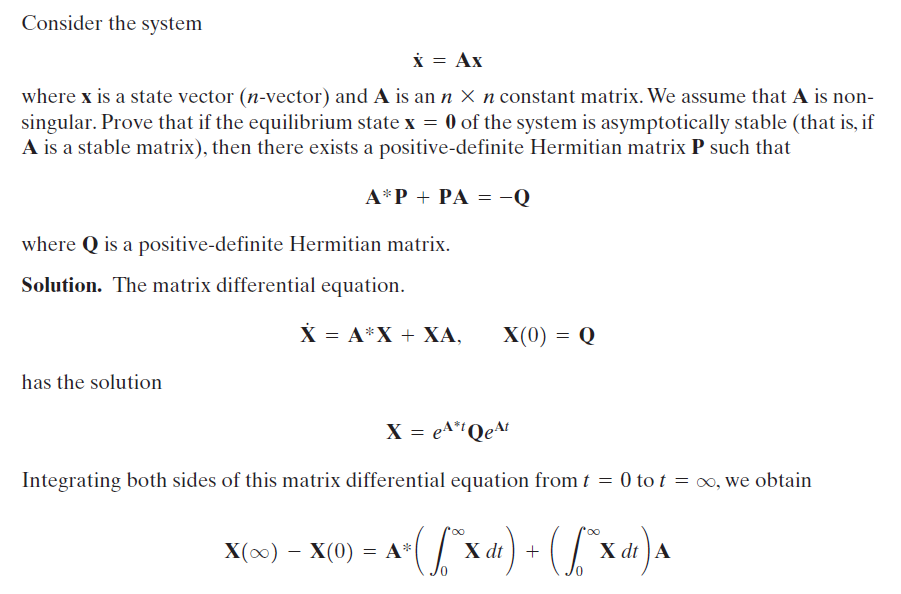


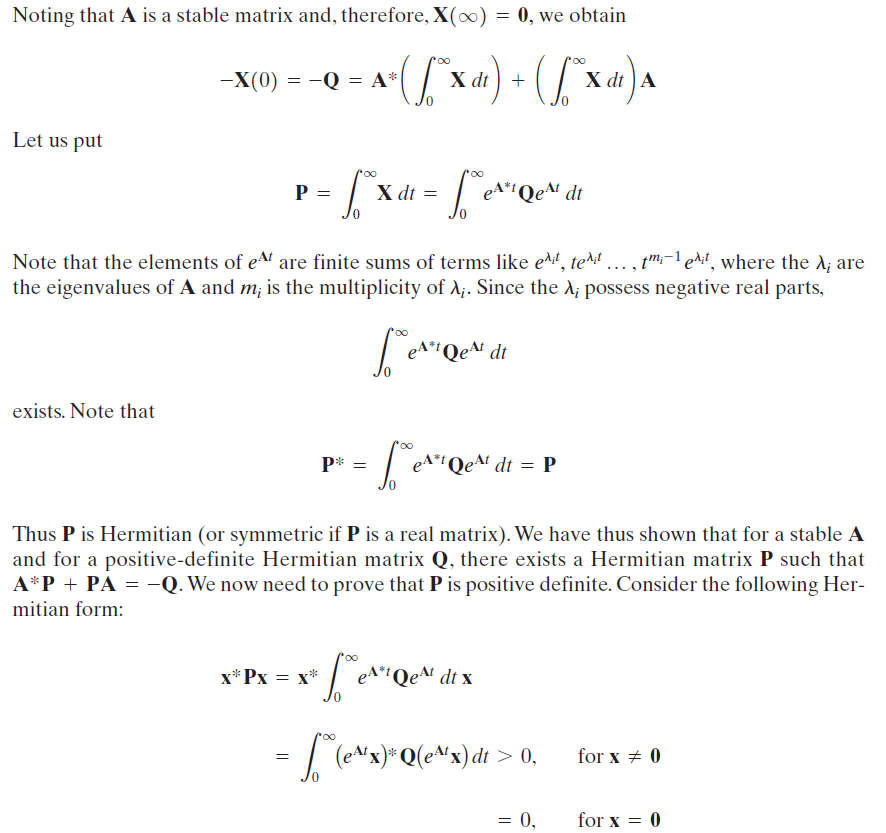




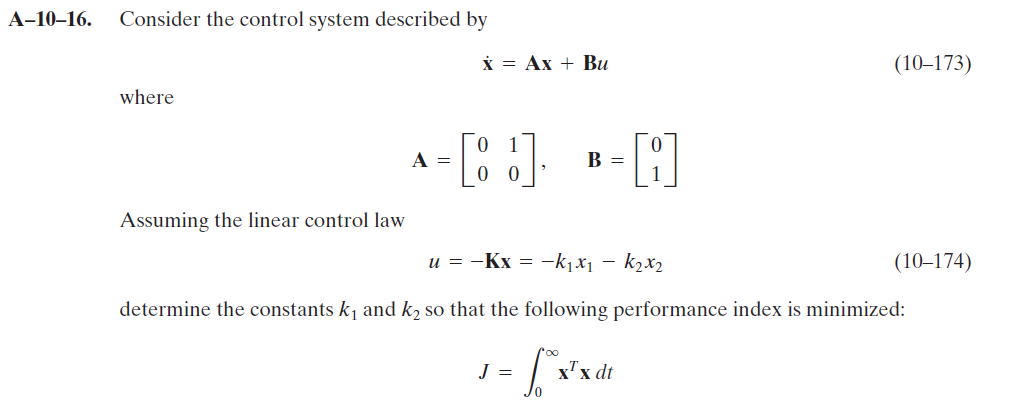


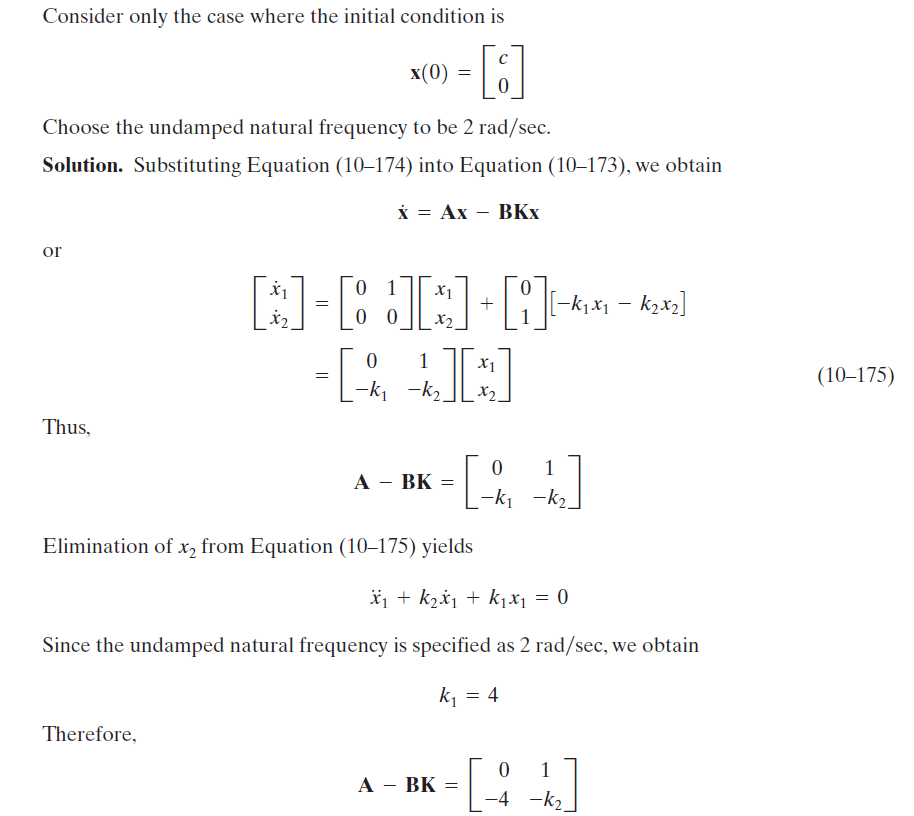
**Proof 1 for P is a Positive Definite Matrix**

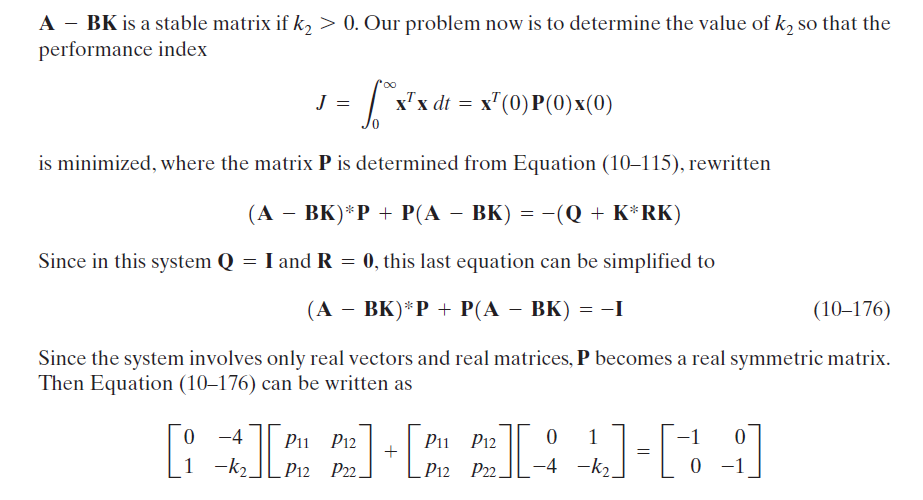


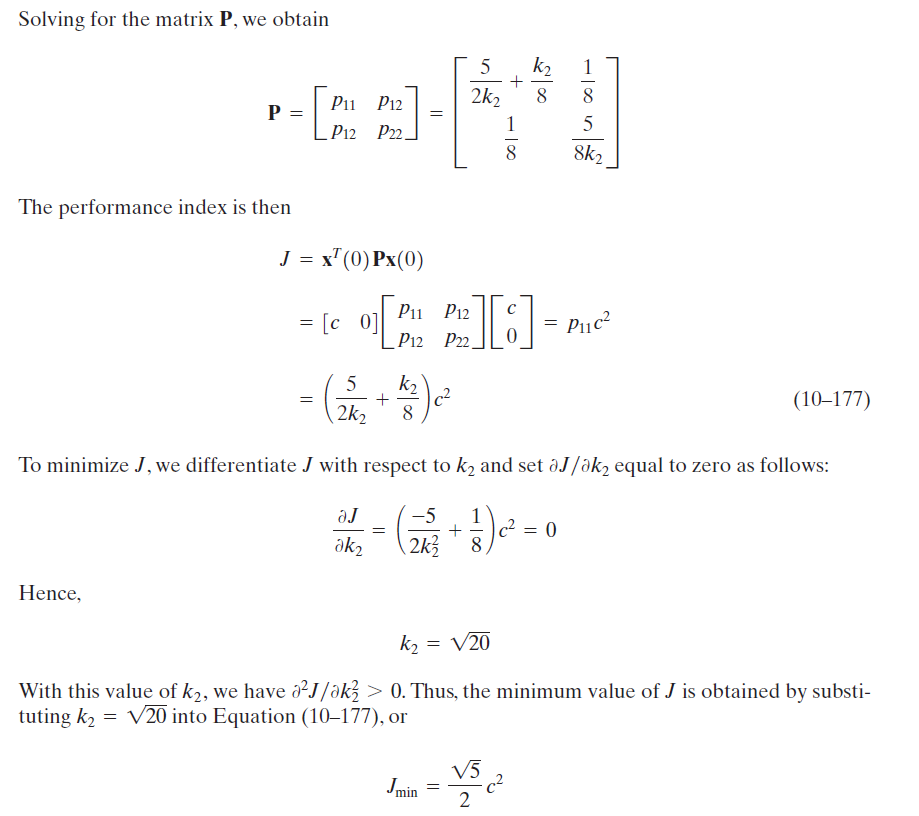


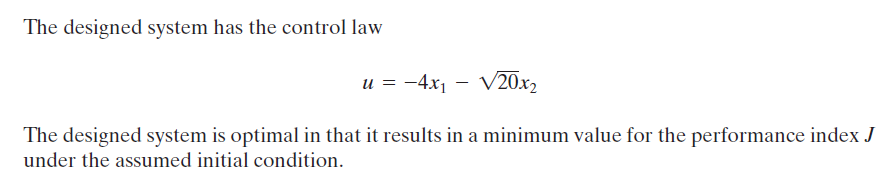
**Proof 2 for Minimization of J w.r.t k with an example**





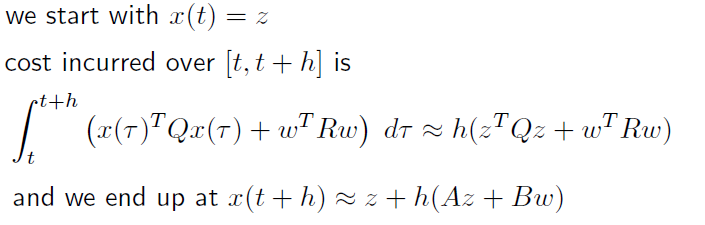


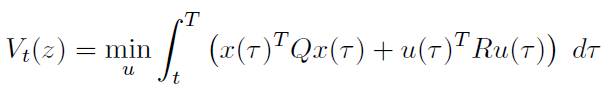




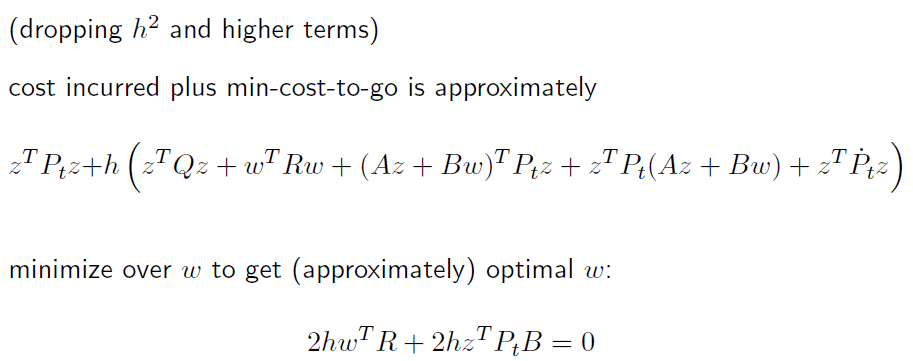
|  |
| --- |
| Note: The crucial and difficult task in the LQR controller design is a choice of the weighting matrices. We generally select weighting matrices Q and R to satisfy expected performance criterion. The different Q and R values give a different system response. The system will be more robust to disturbance and the settling time will be shorter if Q is larger (in a certain range). But there is no straightforward way to select these weighting matrices and it is usually done through an iterative simulation process. |

**Alternate Proof**

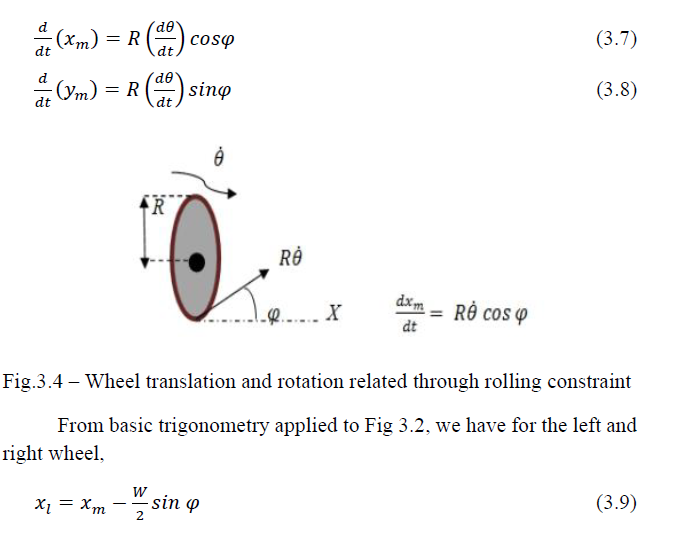
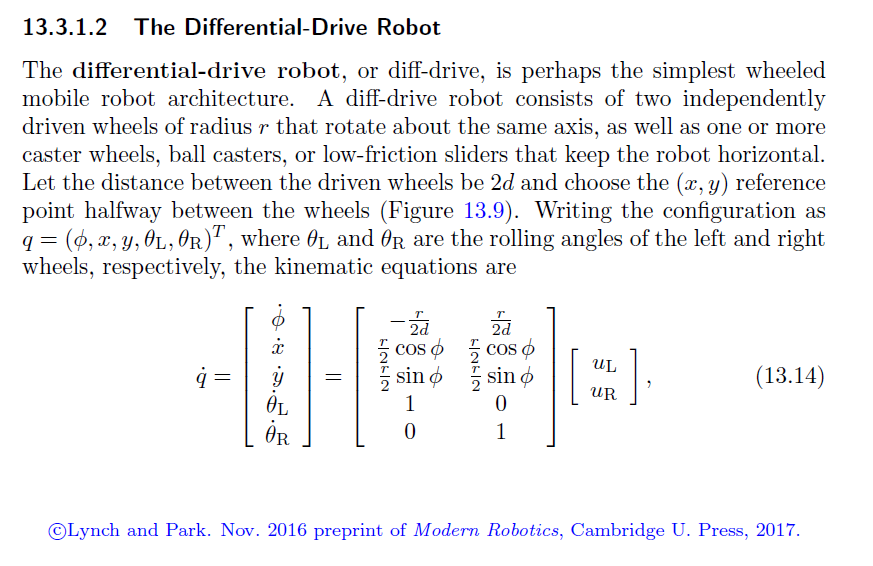


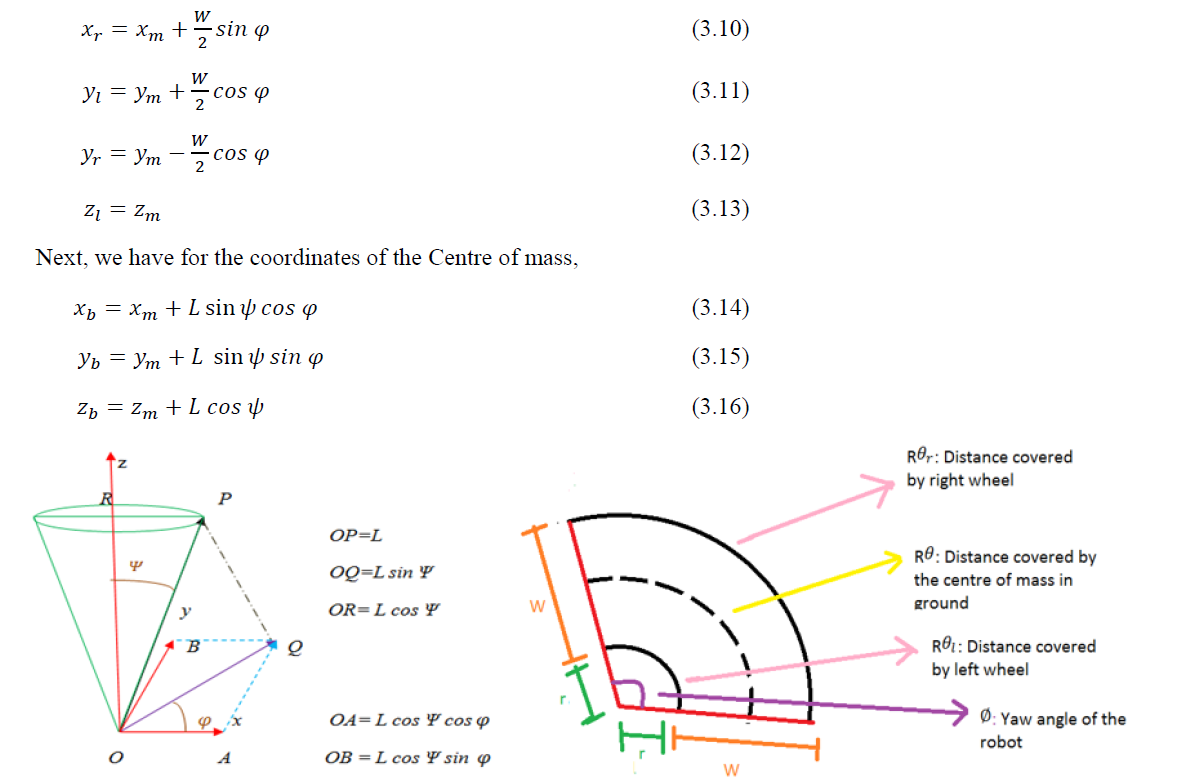


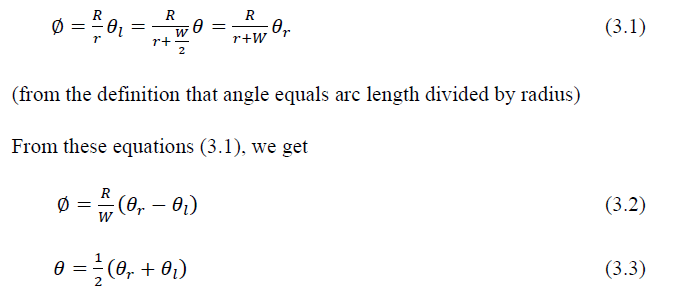




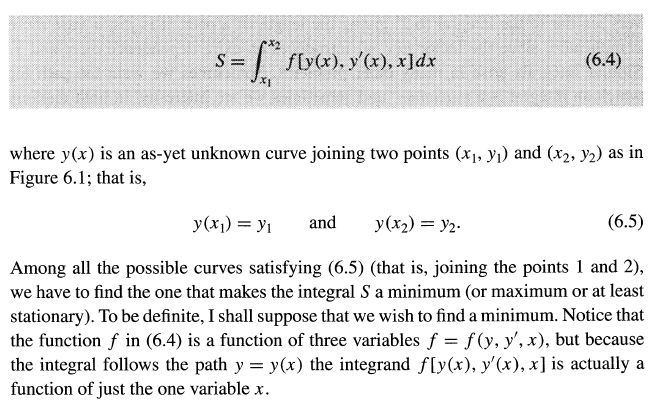
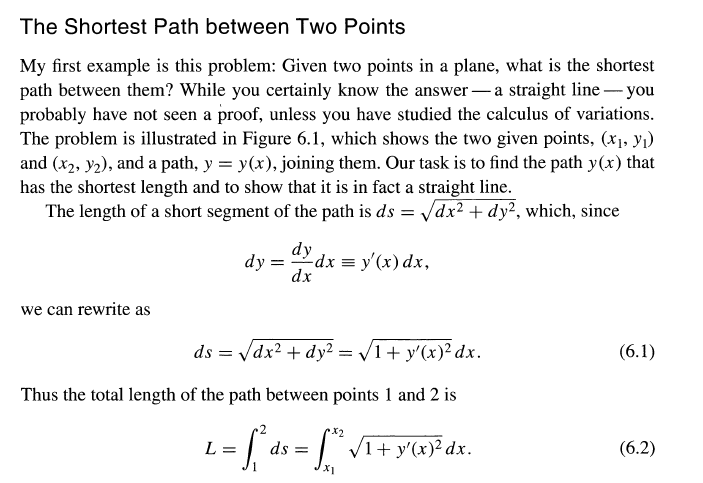
**Mathematical Model for Left and Right Motors – Kinematics**

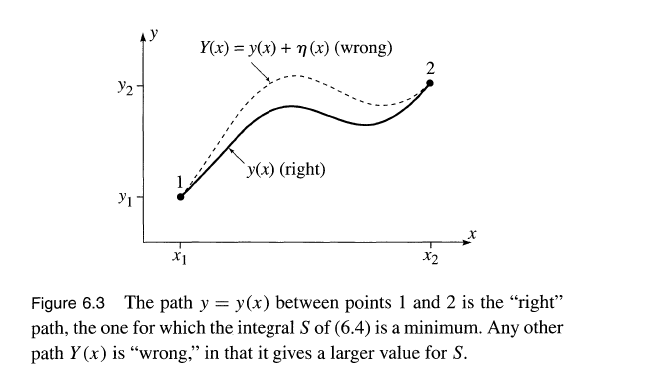


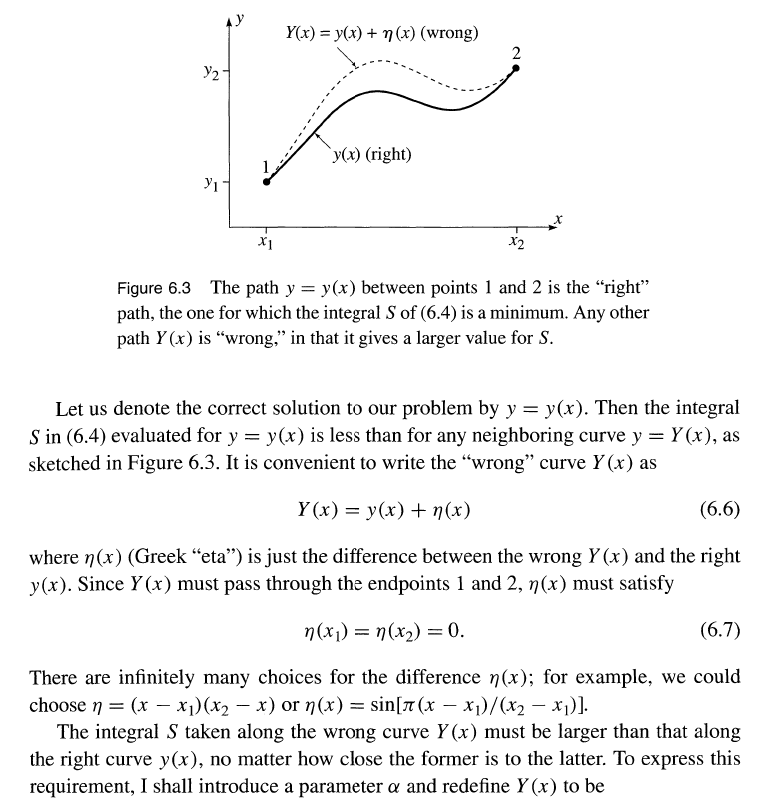


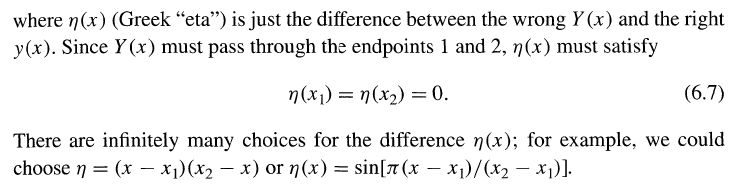


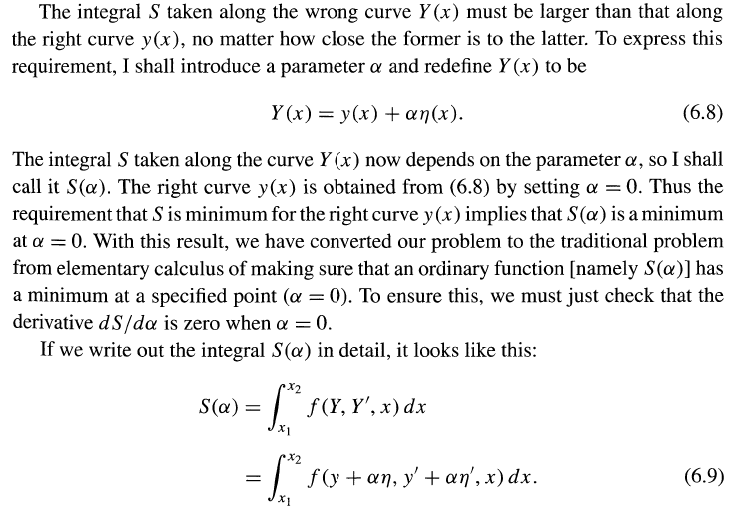
**EULER LAGRANGE EQUATION (**Taylor Classical Mechanics.pdf**)**

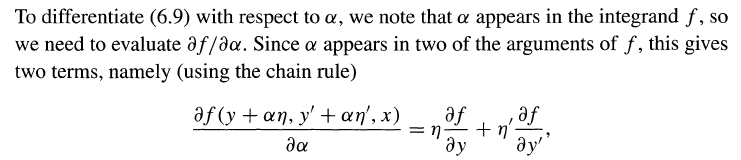


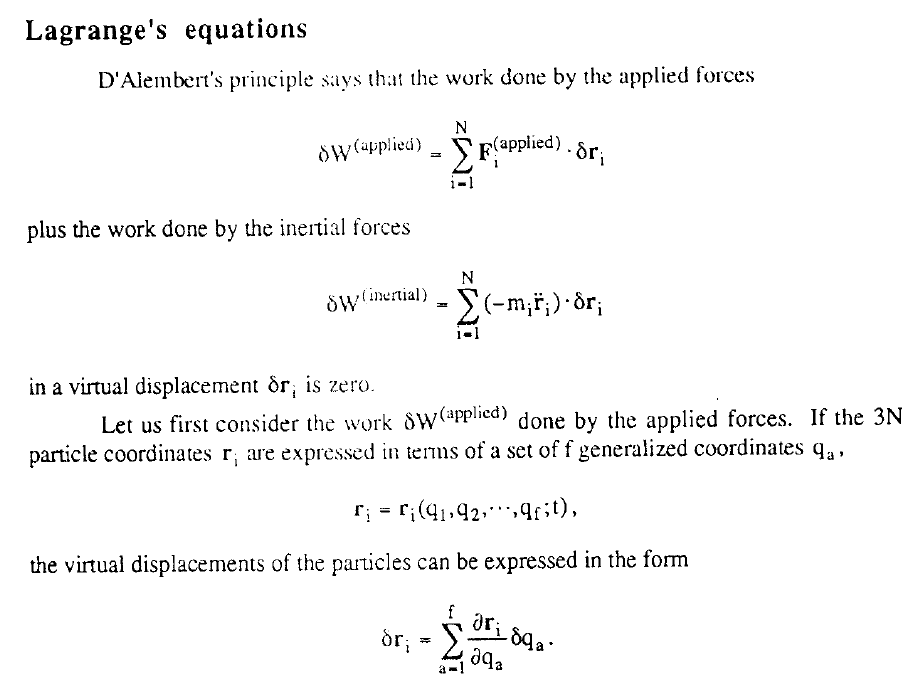
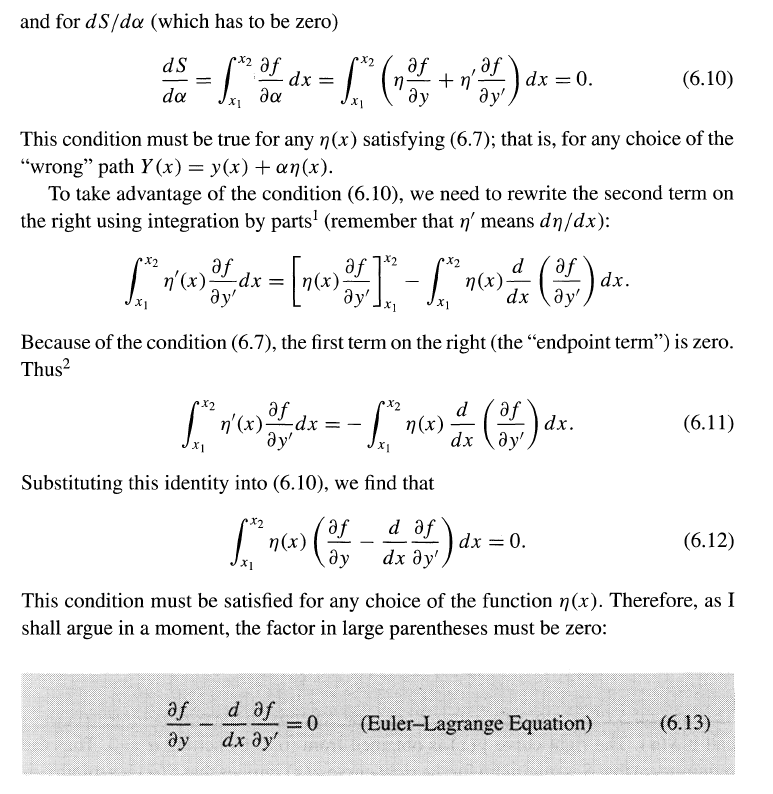


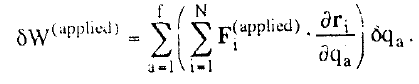


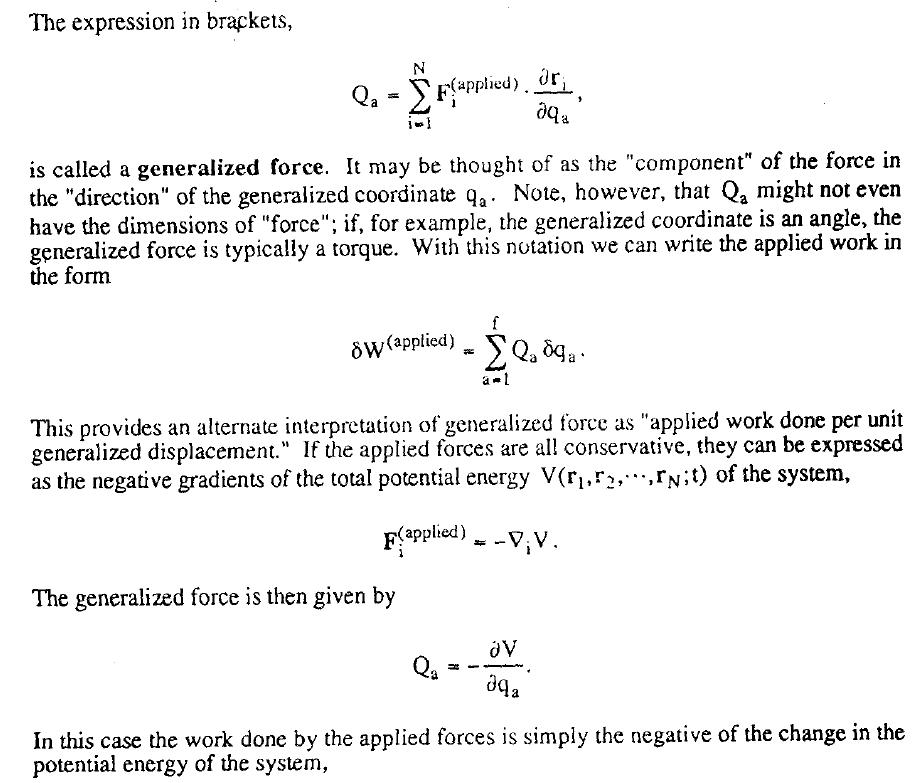


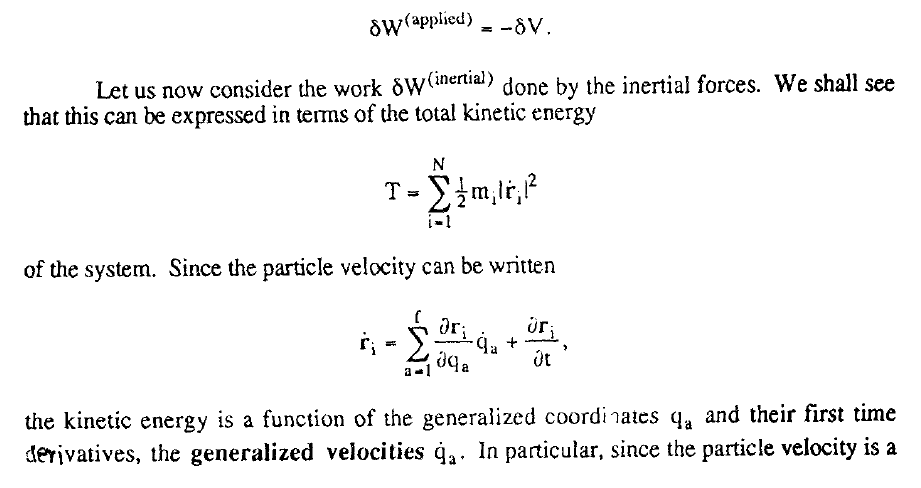


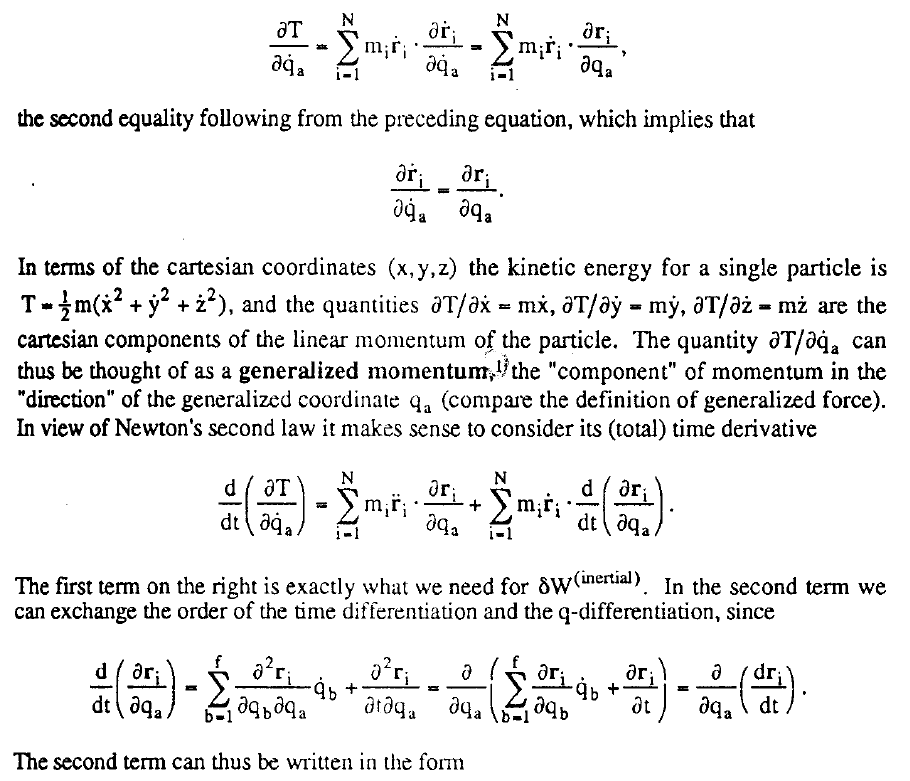


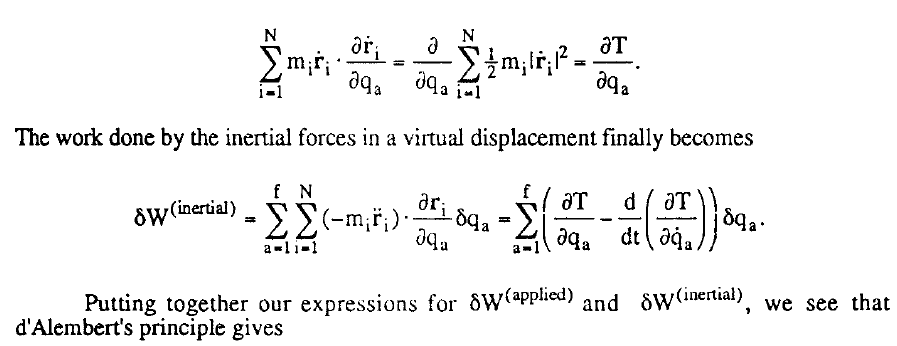


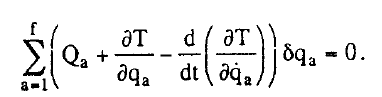


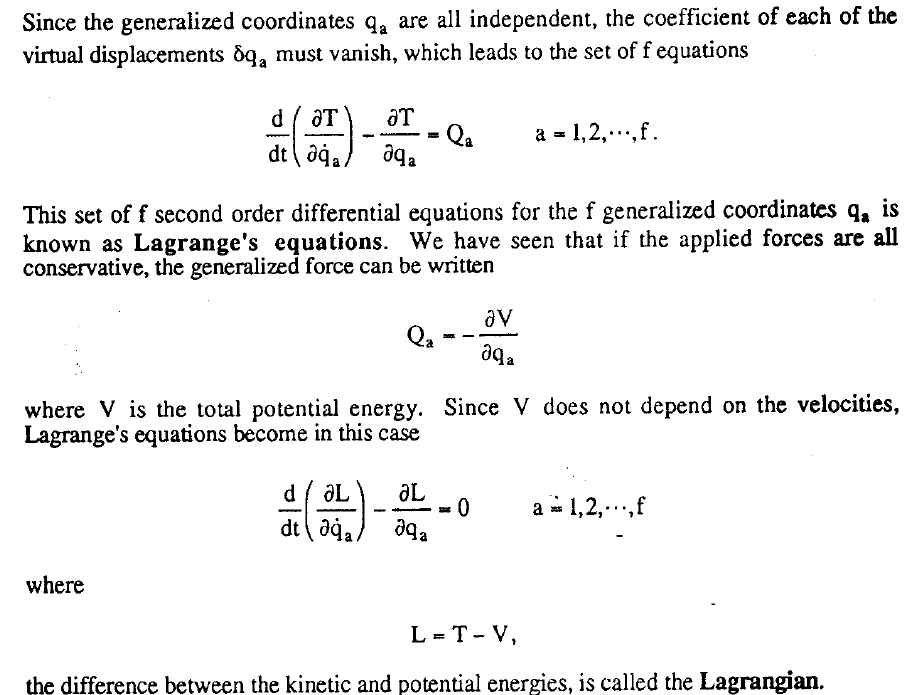


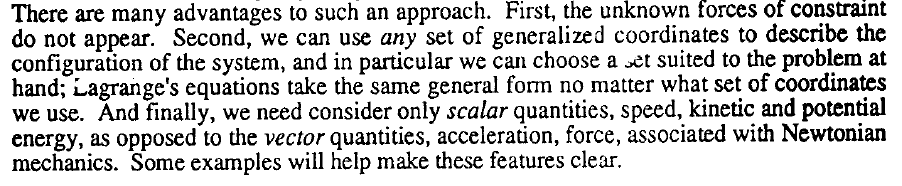


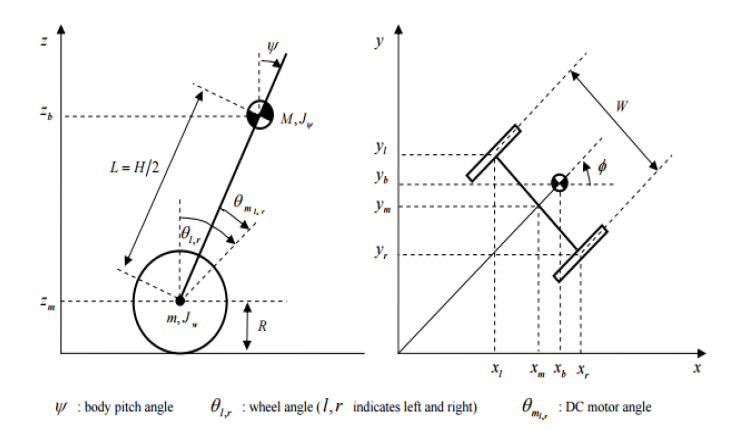




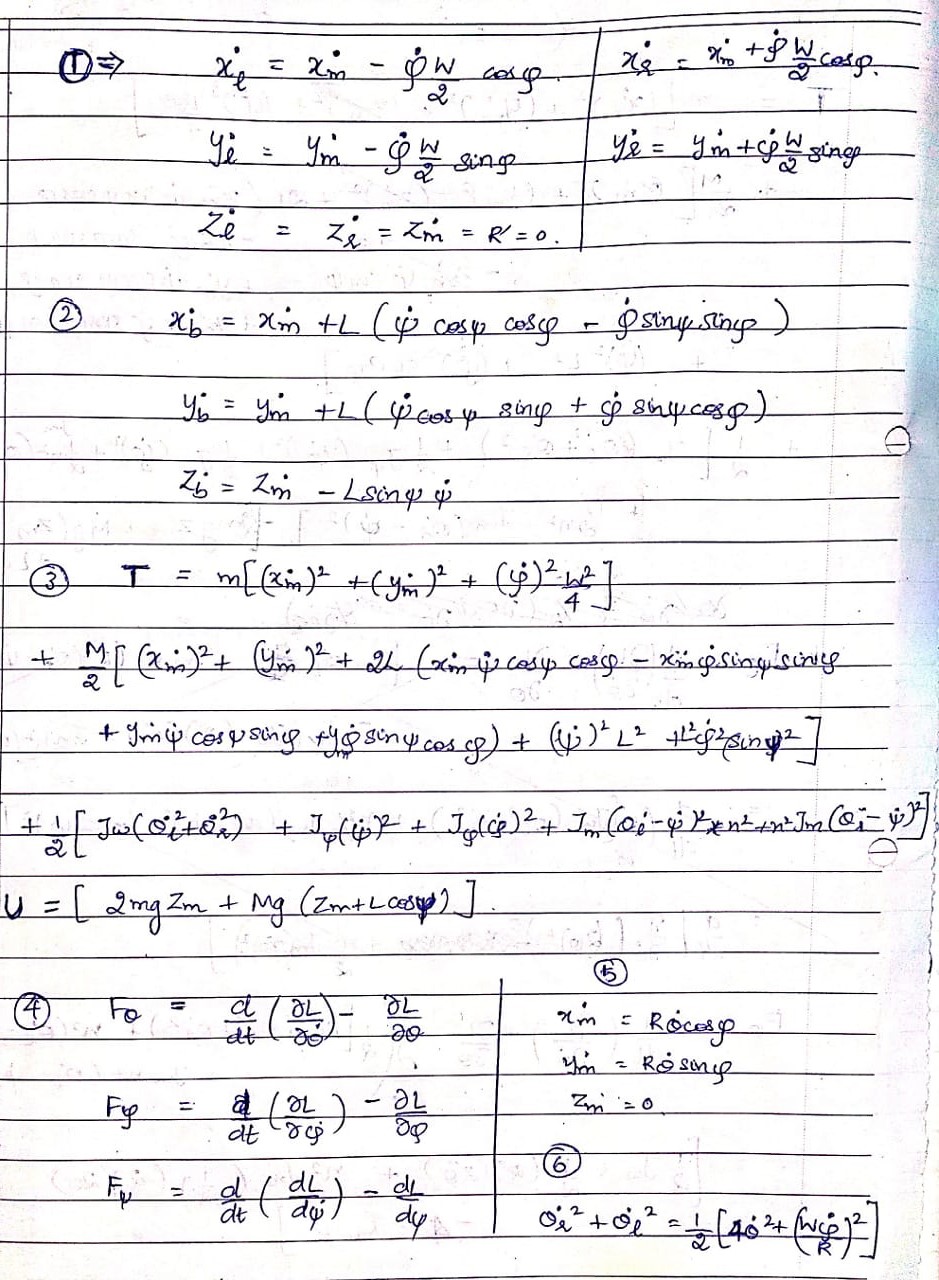




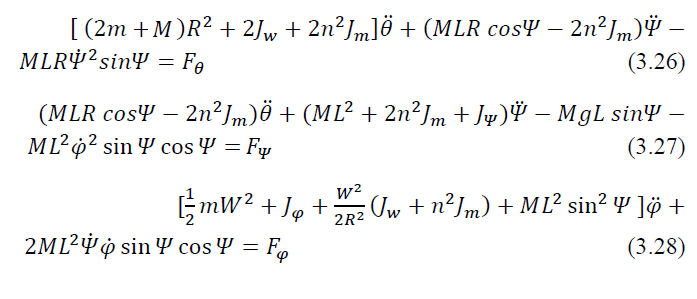
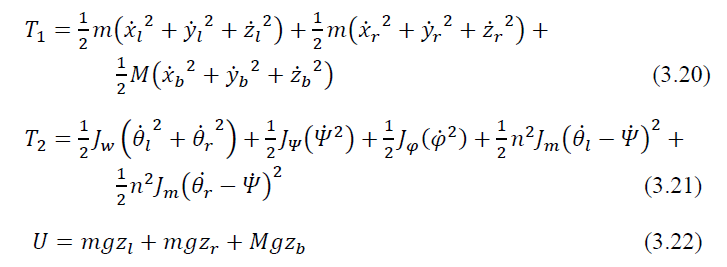




**Lagrange Equation with Mechanics**

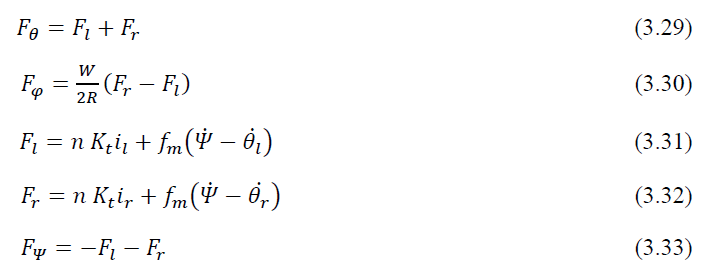


Note: States in the state space are independent of other. d(/dt doesn’t affect ****

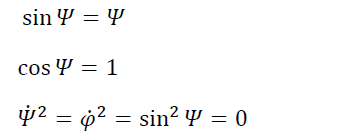


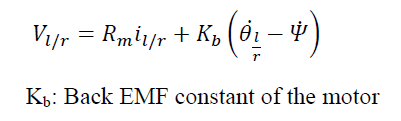
From, generalized Force Eq. – D’Alembert’s Principle, where qi is generalised force

co-ordinates () and ri (Left and Right Wheel) controllable force co-ordinates.

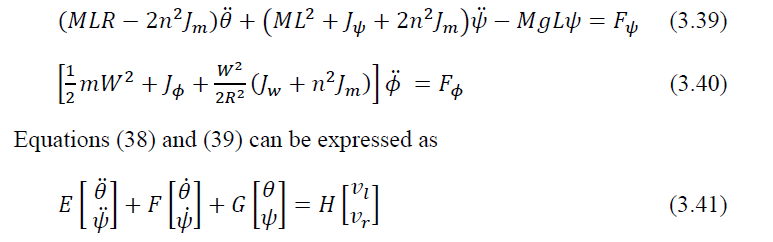


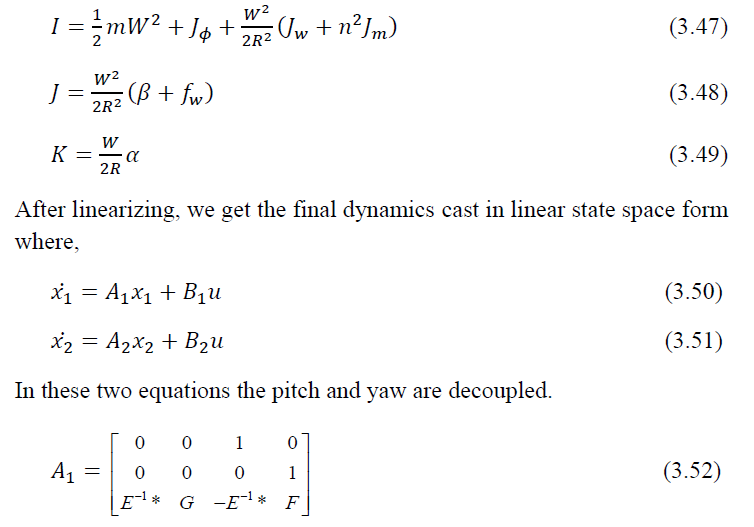
Linearizing the Equation at small angle and neglecting higher order terms.

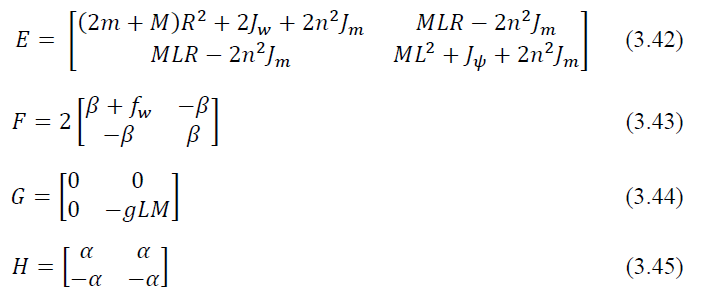


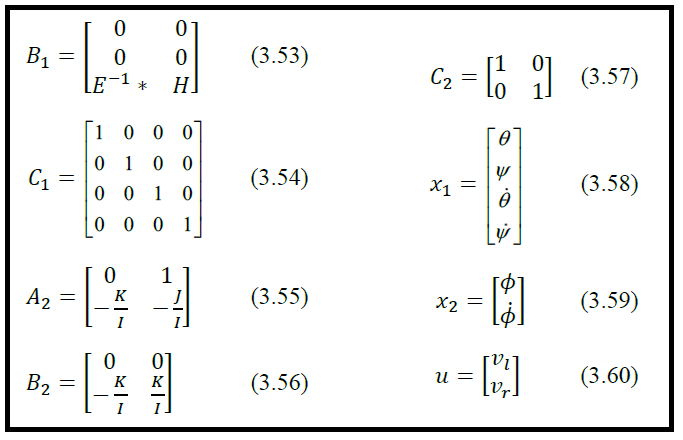
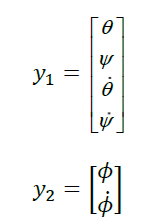


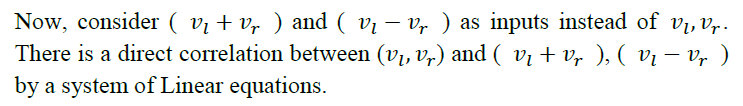


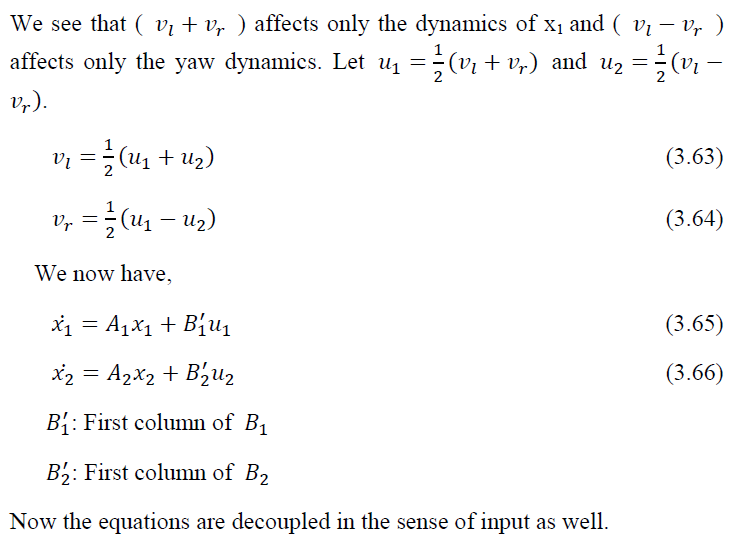
 

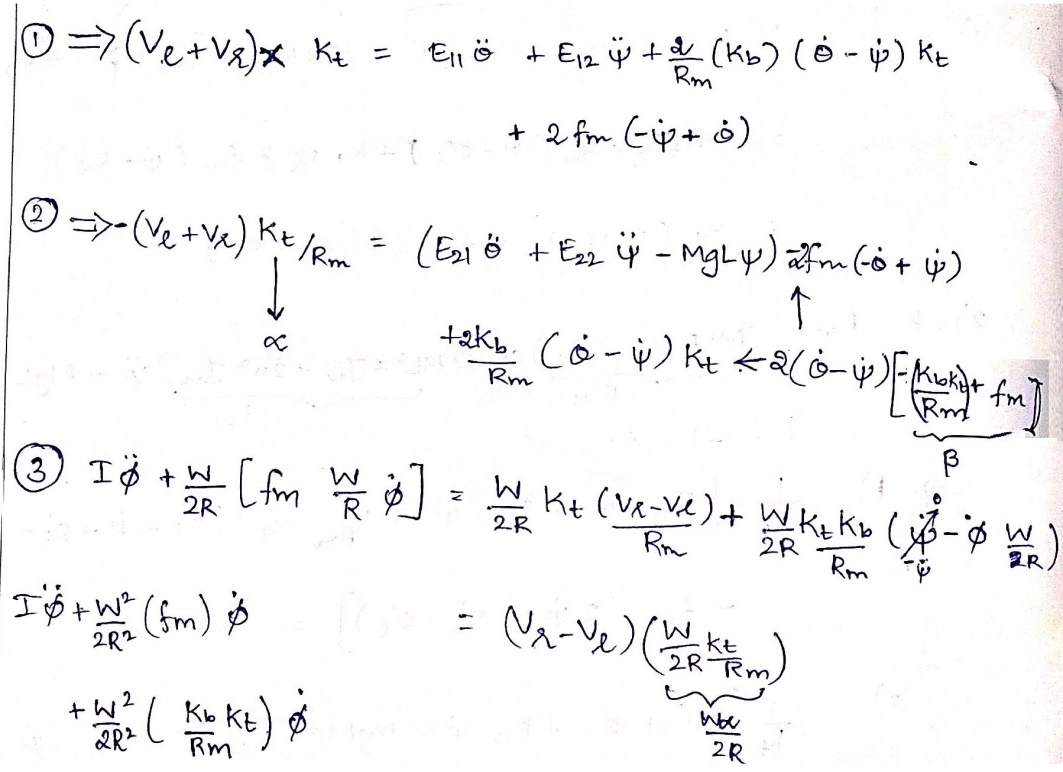
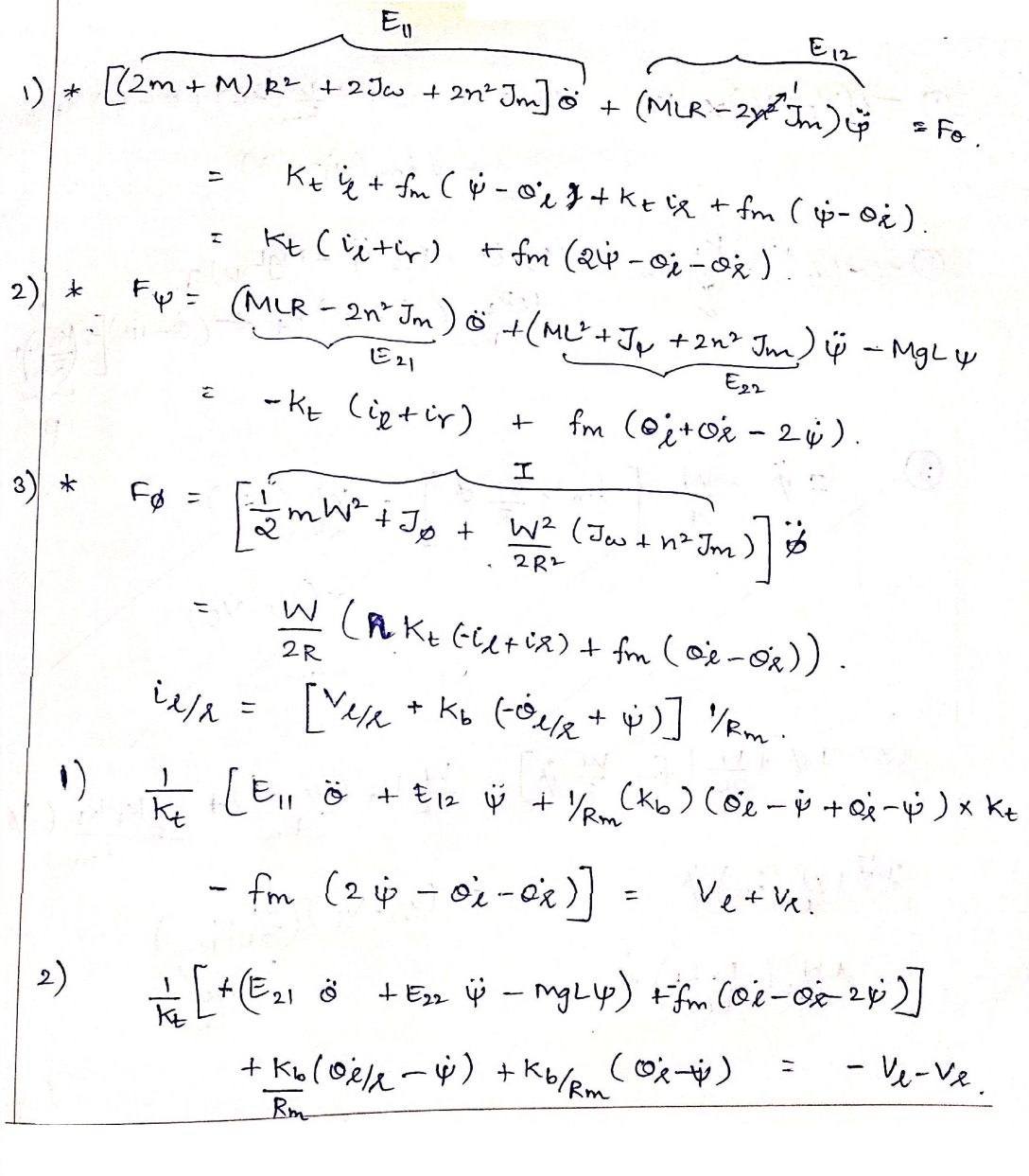


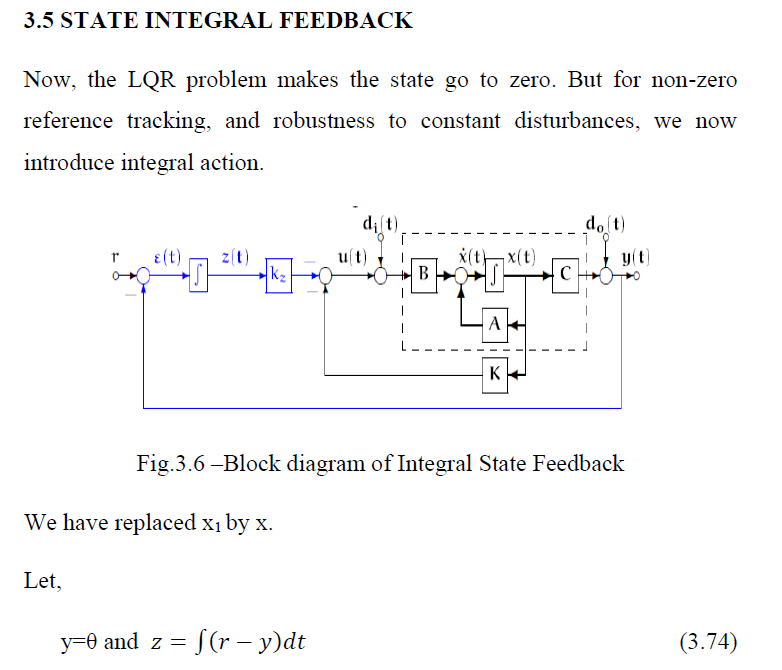


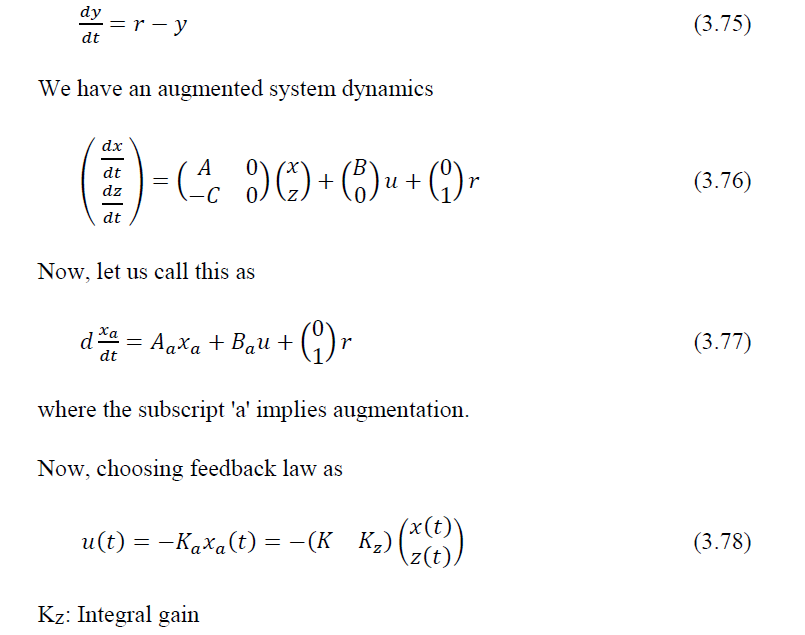
 

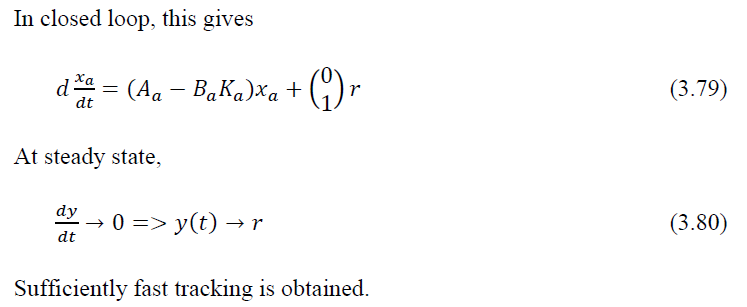












**Motor Model**

