# BALANCING A BALL ON A BEAM

Thesis is presented to fulfil the
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**ABSTRACT**

The purpose of this project is to balance a ball on a beam. The control task is to position a steel ball, which rests on the beam (guided by two wires at both side) at the desired point along the length of the beam using a torque or force applied to the beam angle as the control input. It is also required that the rotation of the beam and the rolling of the ball to occur without any slipping, which imposes a constraint on the rotational acceleration of the beam.

The beam is made to rotate in a vertical plane by applying a torque at the centre rotation and the ball is free to roll (with one degree of freedom) on two nichrome support wires along the beam. The beam angle is adjusted and measured by a precision servo- potentiometer mounted on the pivot axis. The position of the steel ball along the beam is measured using a "Wheatstone Bridge" method, in which the small voltage is generated across the wires is proportional to the position of the ball.

Using the approximated transfer function of the plant derived by Wellstead (1993), lead compensator, double lead compensator and proportional plus derivative continuous controller were designed using root locus approach. Then, the discrete-time equivalents of the analog controllers were obtained.

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# 1.0 : INTRODUCTION

## 1.1 General

Many physical systems like the rocket during launching and the inverted pendulum system are unstable. These unstable systems can be stabilised by applying feedback control. Generally, *in an unstable system any disturbances will result in oscillations building up until some part fails. Between the stable and unstable lies the conditionally stable system. A good example of this is an oscillator where the oscillations neither increase or decrease, each cycle being identical to the previous one. However, for most practical systems this condition is to be avoided' (Franklin, F. G. and Powell, D. J., 1986).*

Actually the purpose of this project is to position a steel ball at the desired point along the length of the beam by using a torque or force applied to the beam angle as the control input. The beam is made to rotate in a vertical plane by applying a torque at the centre rotation and the ball is free to roll (with one degree of freedom) on two nichrome support wires along the beam. The beam angle is adjusted by applying a certain voltage to the motor which is directly attached to the beam. The beam angle is measured by using a precision servo-potentiometer mounted on the pivot axis. The position of the steel ball along the beam is measured using a "Wheatstone Bridge" method in which the small voltage generated across the wires is proportional to the position of the ball.