SNS COLLEGE OF TECHNOLOGY

(An Autonomous Institution)

COIMBATORE-35

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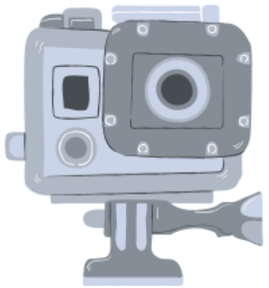
DEPARTMENT OF BIOMEDICAL ENGINEERING

COURSE NAME: 19BMT301/ BIOCONTROL SYSTEM

III YEAR / V SEMESTER

Unit 5 – Physiological Control System

Topic 2: Transient Analysis of Neuromuscular Reflex Action

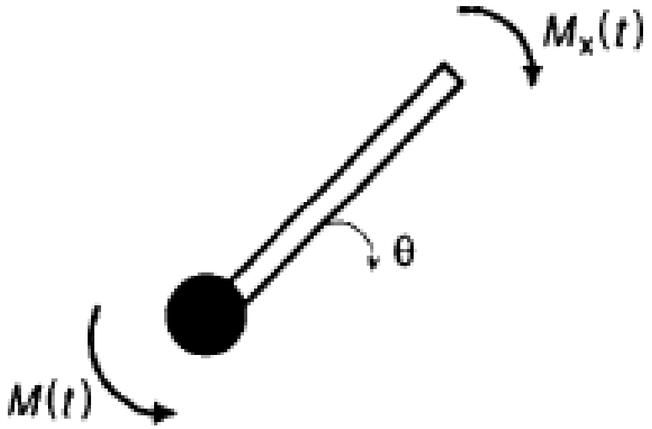


Neuromuscular Reflex Motion

- Examination of the dynamics of neuromuscular reflex motion can yield valuable insight into the status of patients who have neurological disorders.
- The patient is seated comfortably and his shoulder and elbow are held by adjustable supports so that the upper arm remains in a fixed horizontal position throughout the test.
- The subject's forearm is allowed to move only in the vertical plane. At the start of the experiment, he is made to flex his arm by pulling on a cord that has been attached to a cuff on his wrist. The cord runs around a pulley system and supports a sizeable weight.

Neuromuscular Reflex Motion

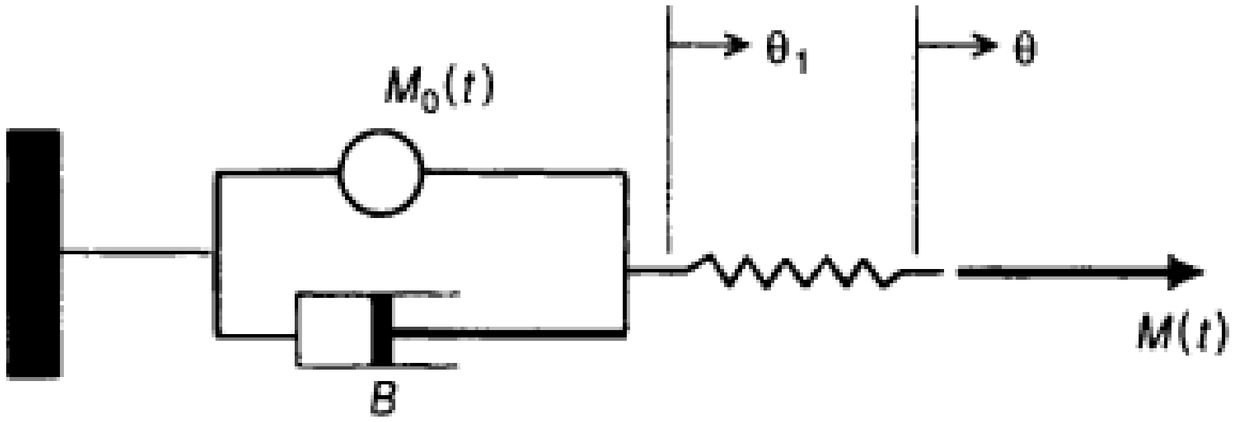
- Then, at time t =0, an electromagnetic catch is switched off so that an additional weight is abruptly added to the original load. Changes in angular motion, θ(t), of the forearm about the elbow are recorded during and after the quick release of the weight.
- **Limb Dynamics:**



$$M_x(t) - M(t) = J\ddot{\theta}$$

Neuromuscular Reflex Motion

- **Muscle Model:**
- Although this reflex involves both the biceps and triceps muscles, we will assume for simplicity that the net muscular torque in response to M, is generated by a single equivalent muscle model.



$$M(t) = k(\theta - \theta_1)$$

$$M(t) = M_0(t) + B\dot{\theta}_1$$

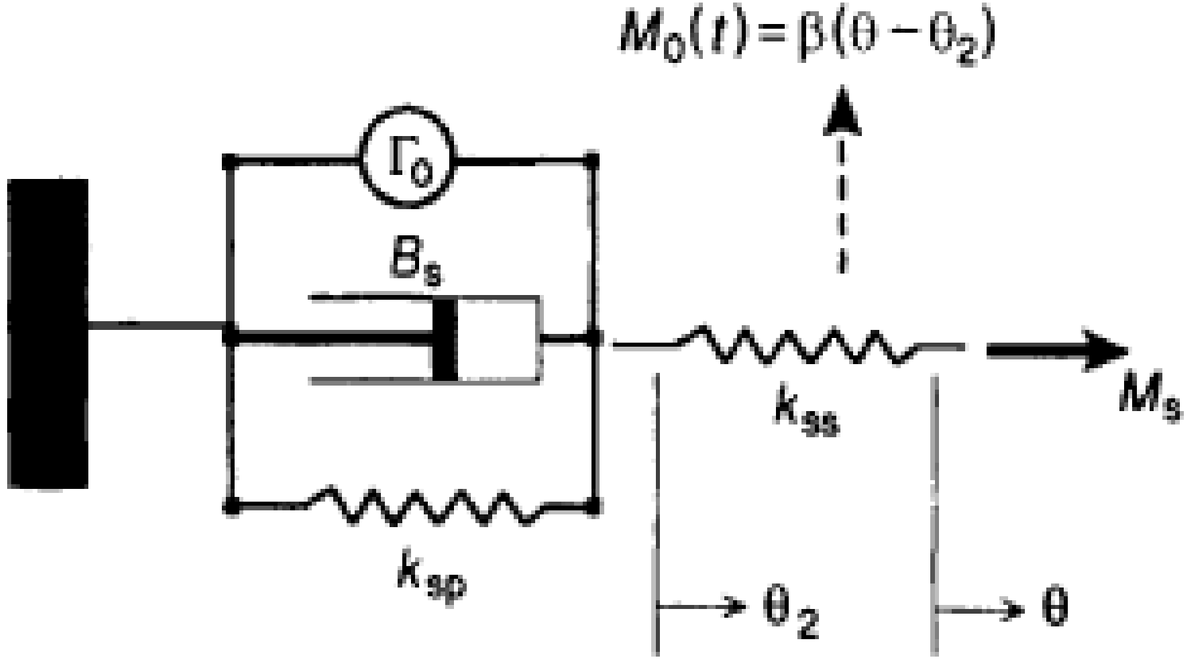
Neuromuscular Reflex Motion

- **Plant Equation:**
- Although this reflex involves both the biceps and triceps muscles, we will assume for simplicity that the net muscular torque in response to M, is generated by a single equivalent muscle model.

$$\frac{BJ}{k}\dddot{\theta} + J\ddot{\theta} + B\dot{\theta} = M_x(t) - M_0(t)$$

Neuromuscular Reflex Motion

- **Muscle Spindle Model:**
- This model describes the dynamics by which changes in θ are transduced at the level of the muscle spindles into afferent neural signals.
- The latter travel to the spinal cord, which sends out efferent signals to the contractile machinery of the muscle to generate Mo(t).



$$M_0(t) = \beta(\theta - \theta_2)$$

Neuromuscular Reflex Motion

- **Muscle Spindle Model:**
- The dynamics of the muscle spindle model may be characterized by the following equations:

$$M_s = K_{ss}(\theta - \theta_2)$$

$$M_s = B_s\dot{\theta}_2 + k_{sp}\theta_2$$

- Another important factor that must be taken into account is the fact that, although θ is sensed virtually instantaneously by the spindle organs, there is a finite delay before this feedback information is finally converted into corrective action at the level of the muscle.
- This total delay, Td, includes all lags involved in neural transmission along the afferent and efferent path ways as well as the delay taken for muscle potentials to be converted into muscular force.

Neuromuscular Reflex Motion

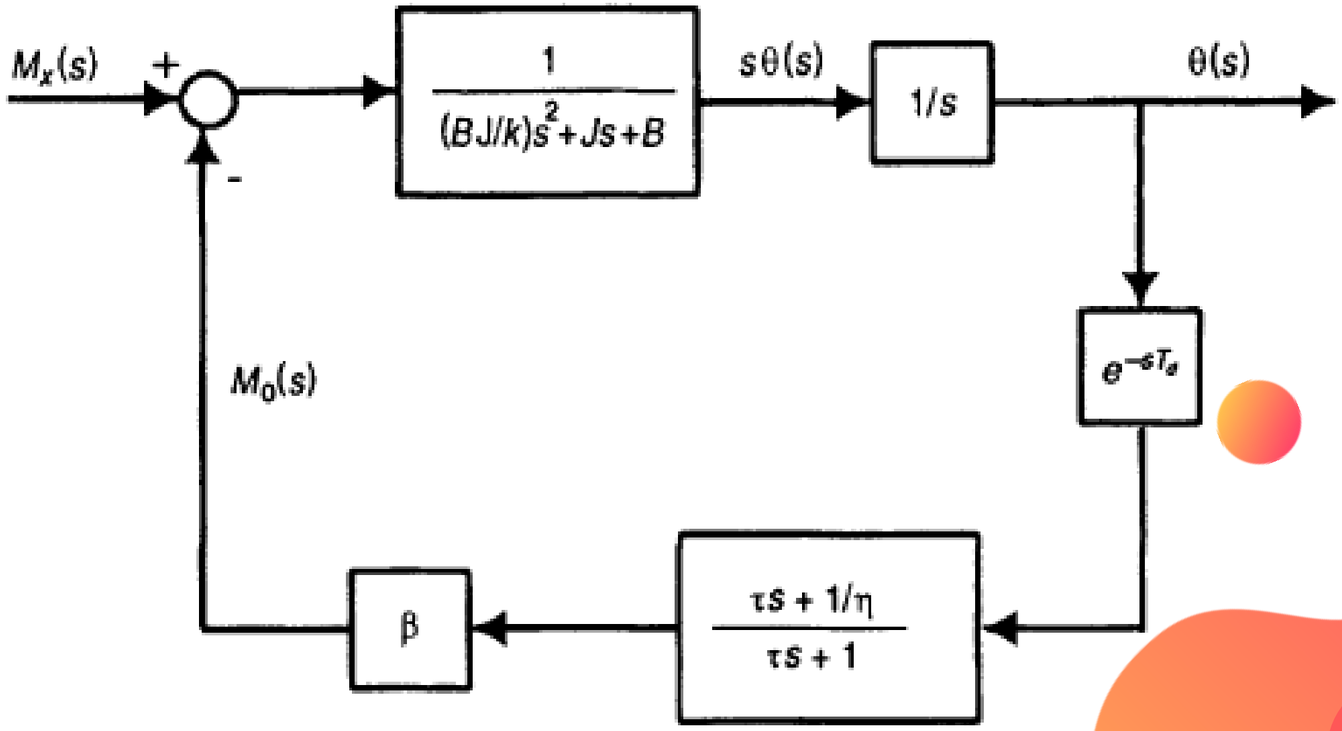
- **Muscle Spindle Model:**
- Eliminating the intermediate variables, Ms, and θ2

$$M_0 + \frac{M_0}{\tau} = \beta\left(\dot{\theta}(t - T_d) + \frac{\theta(t - T_d)}{\eta\tau}\right)$$

- Where

$$\tau = \frac{B_s}{k_{ss} + k_{sp}}$$

$$\eta = \frac{k_{ss} + k_{sp}}{k_{sp}}$$



ASSESMENT

Dear student,

Quiz is posted in your Google class room

Allotted time for quiz is 5 min

No of Questions is 10

KEEP
LEARNING..

Thank u

SEE YOU IN NEXT CLASS