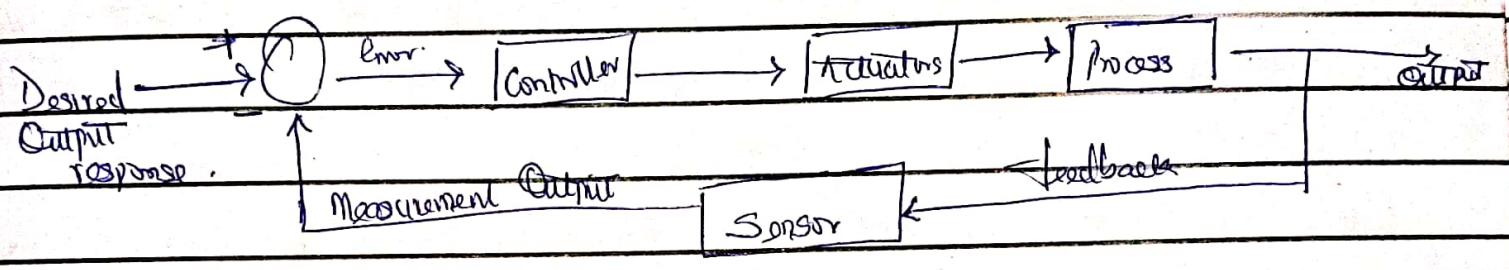
OLEBOADE RUKAYAH KINANI
17/ENG08/004
BIOMEDICAL ENGINEERING
BME 312.
BIOLOGICAL SYSTEM OF CONTROL AND MODELLING.
ASSIGNMENT.

Question 1.



Closed-loop feedback system.

Assumption:

Assuming the position of the End-effector on microsurgical Device can be measured and available for feedback.

Then the actual position of End effector on the microsurgical device can be measured with the sensor in the feedback, the measured position is compared with the desired End-Effector position.

Based on the error controller "$G_c(s)$" is operated on the microsurgical robotic Manipulator which changes the position of the end effector.

Input : Desired End-effector Position.

Controller : Control System $G_c(s)$.

Process : microsurgical robotic manipulator

Measurement Device : Sensor $G_s(s)$

Output : Actual End-Effector Position.

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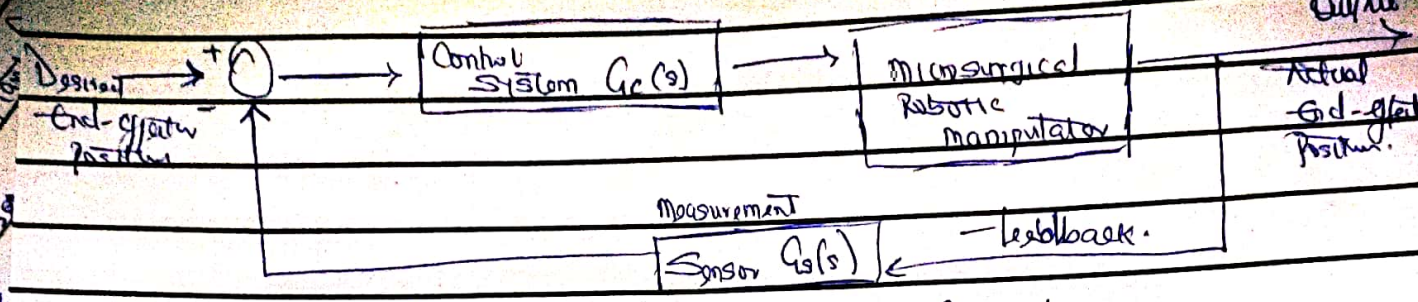

Operation of the feedback Control loop.

QUESTION 2.

A Control System is an arrangement of Physical Component Connected or related in such manner as to Command, direct or regulate itself or another system. In Control system we have Input and Output.

- Input is the stimulus excitation or Command applied to a Control system typically from external energy source, usually in order to produce a specified response from the Control system.
- Output is the actual response obtained from a Control system. It may or may not be equal to the specified response implied by the input.

Types of Control System.

There are two types, Namely;

* Open loop Control System :- This is one in which the control action is independent of the Output.
* Closed-loop Control System :- This is one in which the control action is kind of dependent on the Output.

FEEDBACK.

This is that property of Closed-loop Control system which permit the output to be Compared with the input to the system so that the appropriate Control action may be formed as some function of the Output and input.

Characteristics of feedback

- increase accuracy
- Tendency towards Oscillation or instability

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— Reduce effect of non-linearities.
— Reduce effect of external Disturbance or Noise.

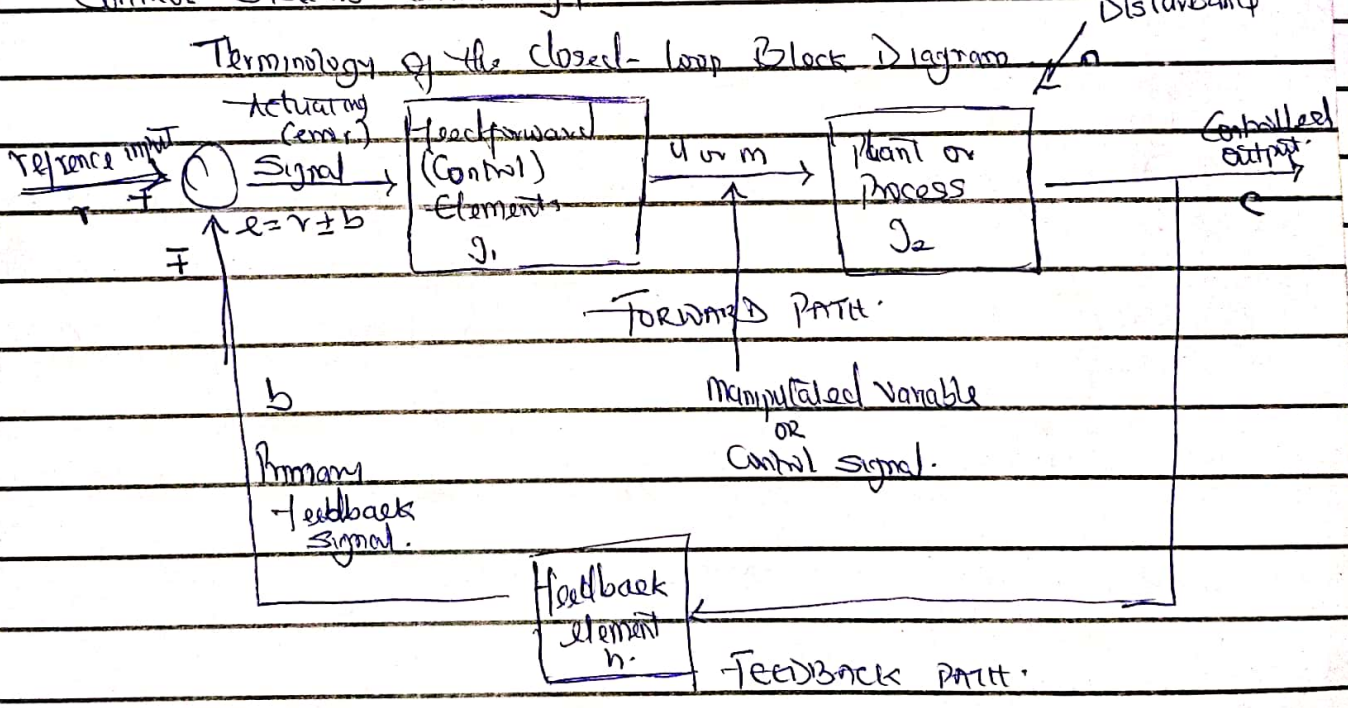
CONTROL SYSTEM MODELS OR REPRESENTATIONS.

To solve a Control System problem, we must put the specification or description of the system configuration and its components into a form amenable to analysis or design. There are three (3) basic representation (models) of components and systems are used, Namely;

1. Mathematical Models : Used to form of differential equation and/or other mathematical relations eg laplace and Z-transform
2. Block Diagram.
3. Signal flow.

CONTROL SYSTEMS TERMINOLOGY

Terminology of the closed-loop Block Diagram



* The plant (or process, or controlled system) (G_2) is the system, subsystem, process or object controlled by the feedback control system.
* Controlled output (c) is the output variable of the plant, under the control of the feedback control system.
* Forward path is the transmission path from the summing point to the

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Controlled output C.

* The feedback (control) elements (g) are the components of the forward path that generate the control signal u or m applied to the plant.

* The Control signal (u) (or manipulated variable m) is the output signal of the feedforward elements g applied as input to the plant G.

* The feedback elements (h) establish the function relationship between the controlled output c and the primary feedback signal b.

* The reference input (r) is an external signal applied to the feedback Control system.

* The primary feedback signal (b) is the function of the Controlled Output c, algebraically summed with the reference input r to obtain the actuating error signal e, that is $r \pm b = e$.

* The actuating (or error) signal is the reference input signal r plus or minus the primary feedback signal b.

NOTE.

— Negative feedback means the summing point is a substraction i.e $e = r - b$

— Positive feedback means the summing point is addition, that is, $e = r + b$

— Feedback elements typically include Sensors of the Controlled Output c, Compensators, and/or Controller elements.

— Feedforward elements include Controller(s), Compensators(s) and/or amplifiers.

REFERENCES.

1. Stubberud, A

REFERENCES.

1. DiStefano, Joseph J.

Schaum's Outline of Theory and Problems of feedback and Control Systems | Joseph J. DiStefano, Allen R. Stubberud, Ivan J. Williams — 2nd ed.

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