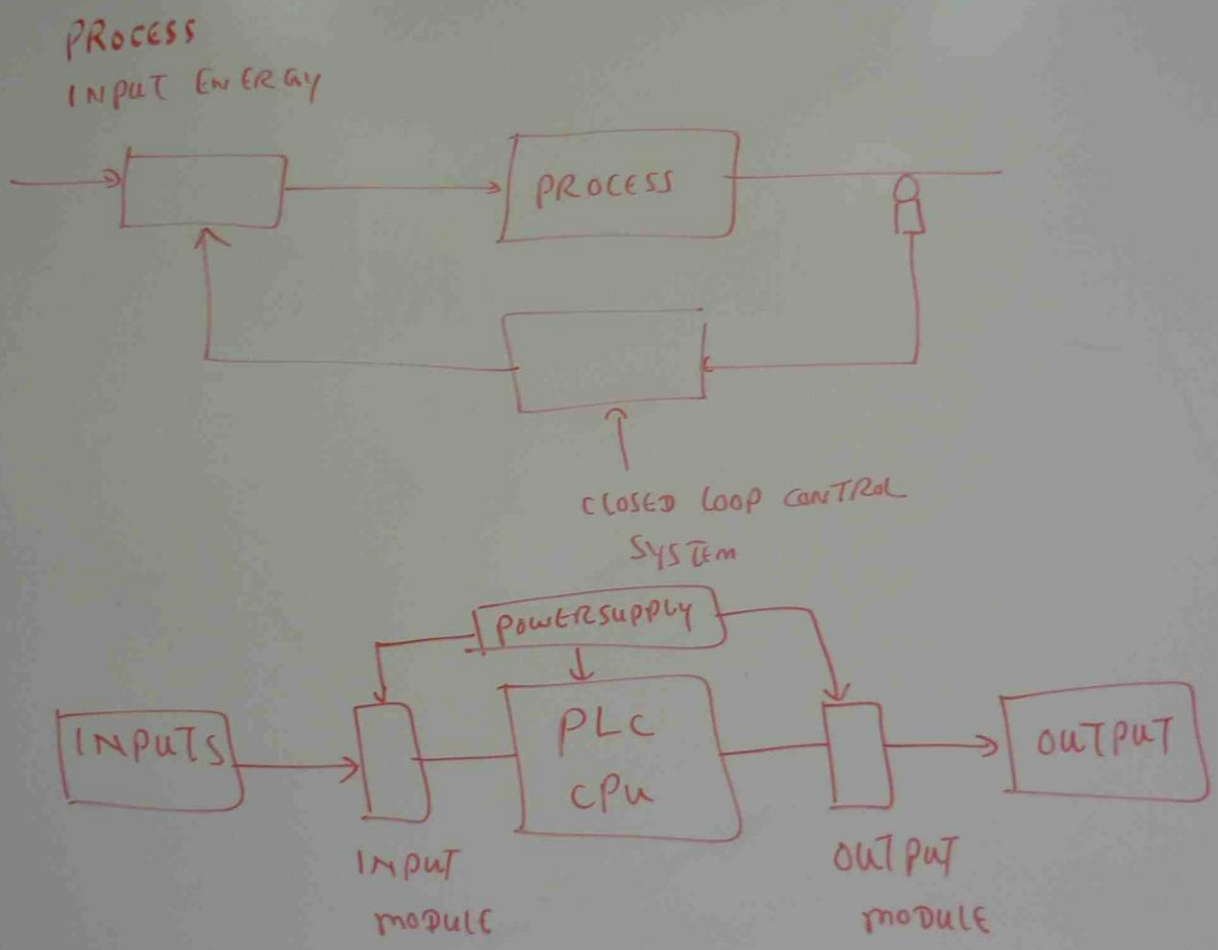
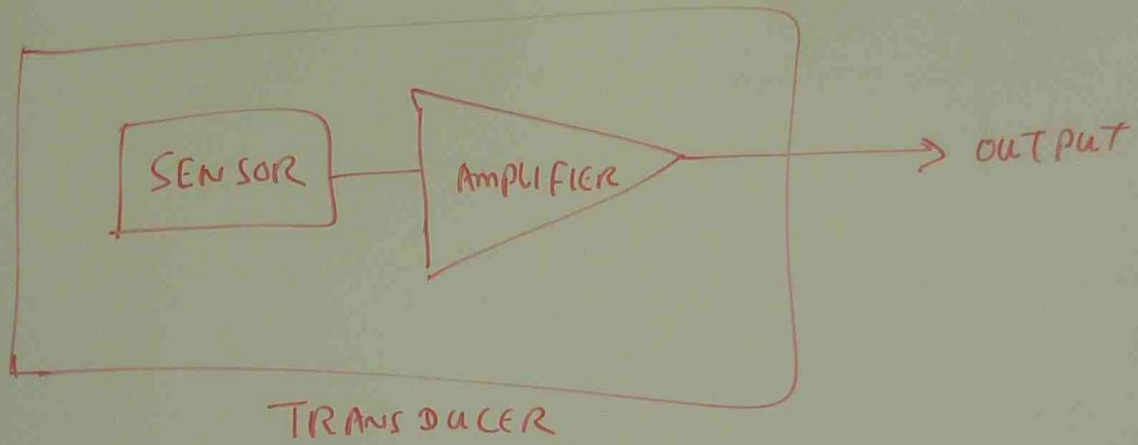
INDUSTRIAL TRANSDUCERS



Block DIAGRAM of PLC SYSTEM

TRANSDUCER & SENSOR

CONSISTS OF SENSOR AND ASSOCIATED CIRCUITRY TO PRODUCE AN OUTPUT SIGNAL



TYPES OF SIGNALS THAT CAN BE MEASURED

RADIATION, MECHANICAL, THERMAL, ELECTRICAL

MAGNETIC, CHEMICAL

THE CHARACTERISTICS of TRANSDUCER DEPEND ON

RANGE — OPERATING RANGE (300C TO 3000C)

SPAN — THE DIFFERENCE BETWEEN THE UPPER AND LOWER VALUES OF THE RANGE

LINEARITY — THE OUT PUT OF TRANSDUCER IS DIRECTLY PROPORTIONAL TO INPUT

SENSITIVITY — AMOUNT OF OUT PUT SIGNAL IN RELATION TO TRANSDUCER IN PUT SIGNAL

RESOLUTION — THE SMALLEST CHANGE OF INPUT SIGNAL THE TRANSDUCER CAN RESPOND TO.

TEMPERATURE MEASUREMENT

THERMOCOUPLE

RESISTANCE TEMPERATURE DETECTOR (RTD)

THERMISTOR

FORCE MEASUREMENT

STRAIN GAUGE

SPEED MEASUREMENT

TACHO GENERATOR

ENCODER

TO CONVERT ANALOG TO DIGITAL SIGNAL

POSITIONAL MEASUREMENT

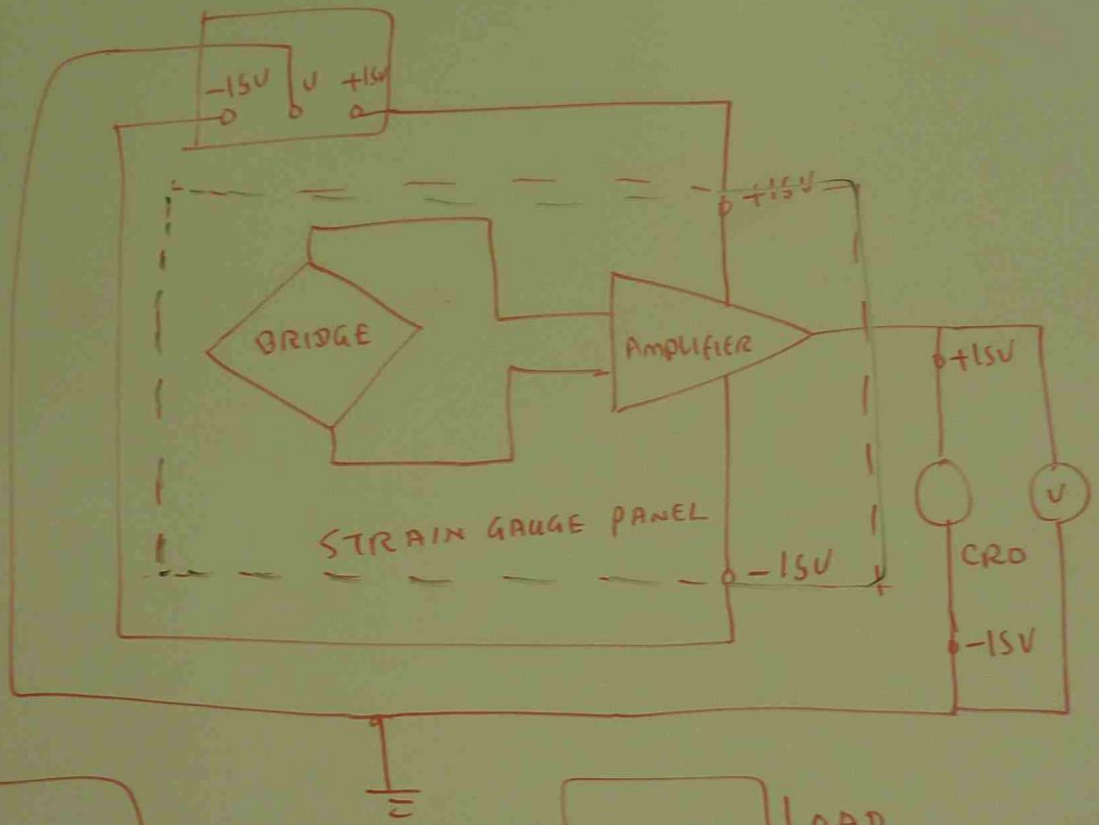
PRECISION POTENTIOMETER

SYNCHROS

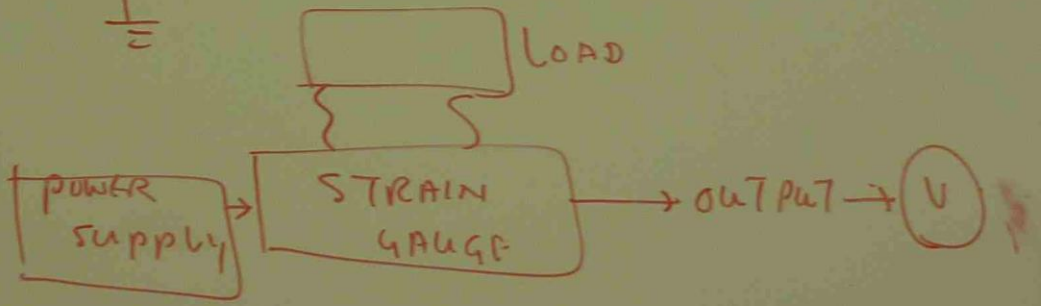
ROTARY TRANSFORMER WHERE THE RELATIONSHIP BETWEEN PRIMARY (ROTOR) AND SECONDARY (STATOR) IS CONTROLLED BY SHAFT ANGLE

FORCE

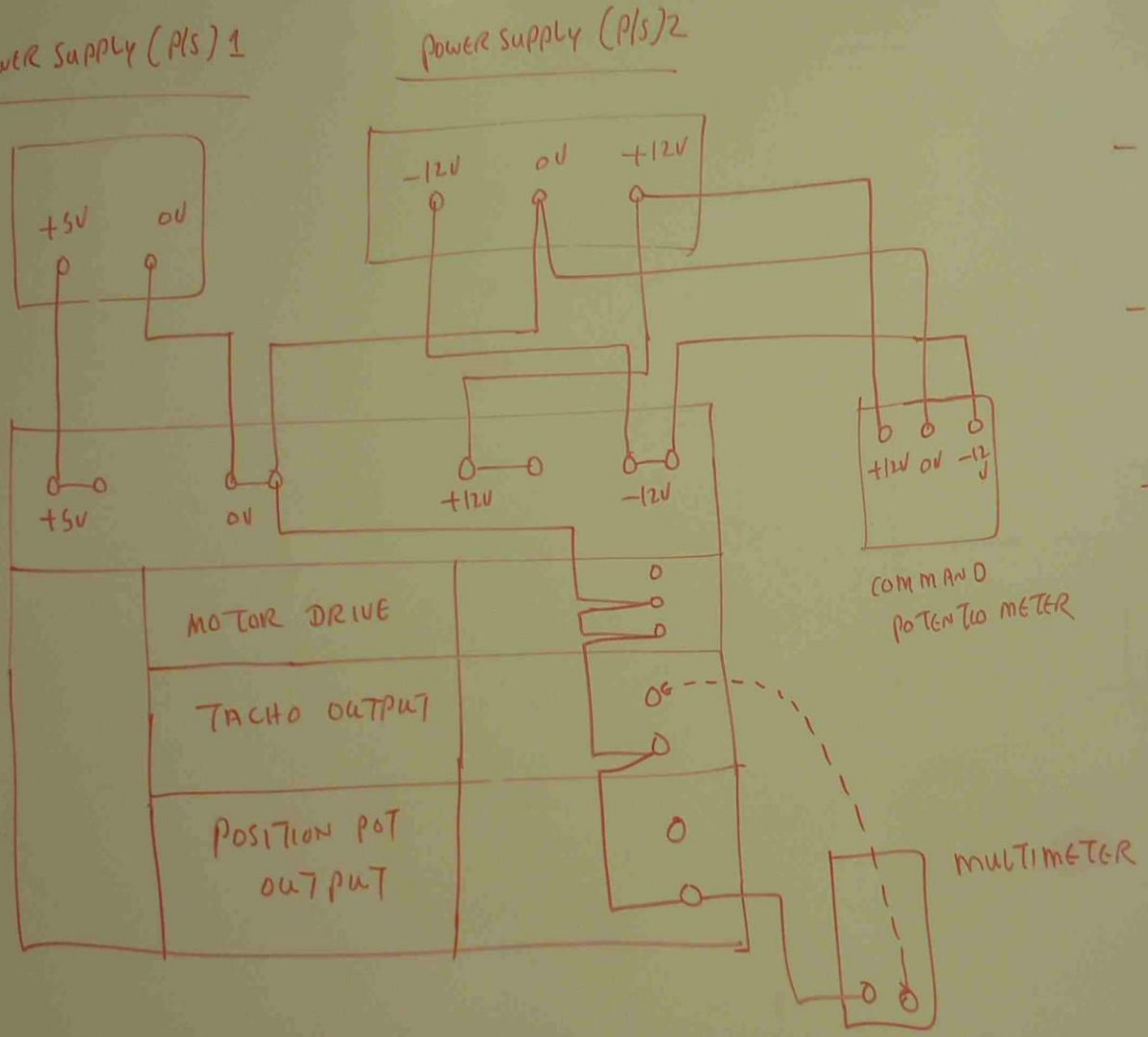
FORCE MEASUREMENT



HE
(ROTOR)
ONTROLLED



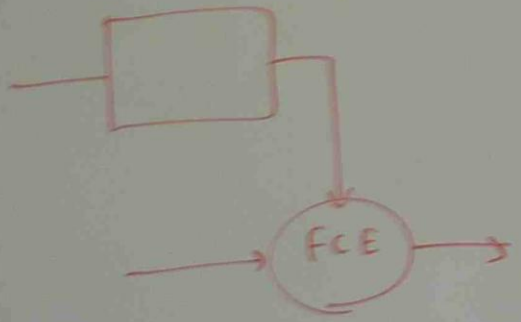
SPEED AND POSITION MEASUREMENT



- CONNECT THE MULTIMETER TO TACHO OUTPUT
- CONNECT THE COMMAND CONTROLLER TO MOTOR DRIVE INPUT
- RUN THE MOTOR
- ADJUST COMMAND POTENTIO METER
- MEASURE TACHO OUTPUT.

FINAL CONTROL ELEMENTS (FCE)

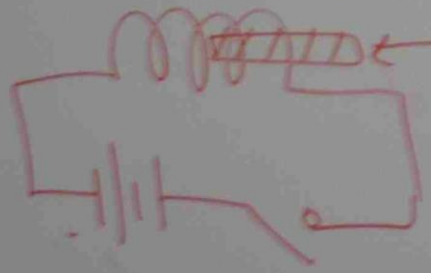
- CONVERTS THE OUTPUT SIGNAL FROM THE CONTROLLER TO CONTROL THE ACTUAL PROCESS SUCH AS TEMPERATURE, PRESSURE, FLOW, LEVEL, SPEED, POSITION ETC

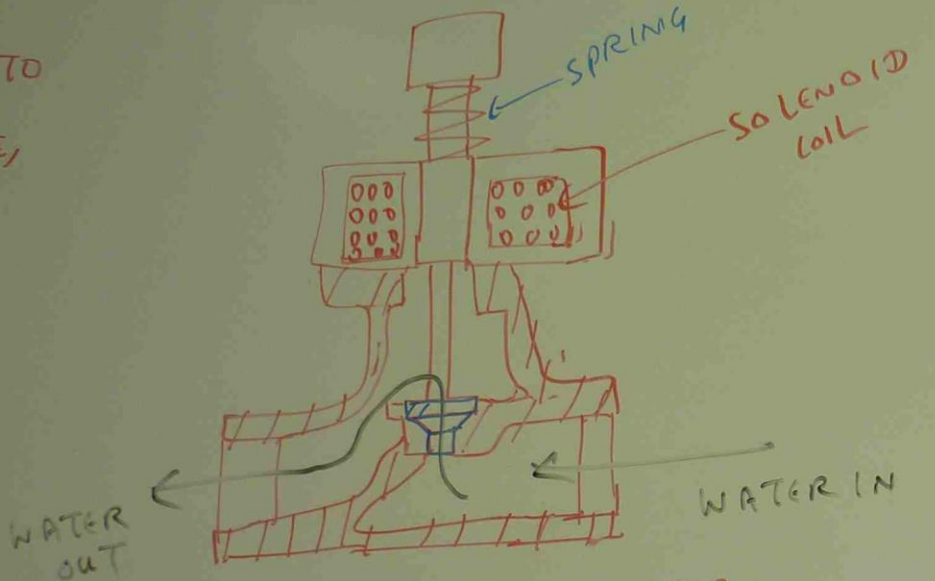


WATER OUT

ELECTROMAGNETIC DEVICES

THE SOLENOID IS AN ELECTRO MAGNETIC DEVICE THAT PRODUCES A STRAIGHT LINE MECHANICAL FORCE



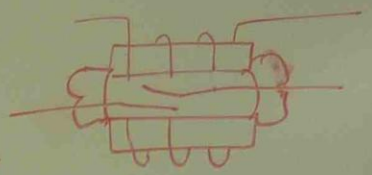


SOLENOID CONTROL WATER VALVE

RELAYS AND CONTACTORS

THESE DEVICES USE THE MECHANICAL MOTION OF A LEVER THAT IS CONNECTED TO A SET OF ONE OR MORE ELECTRICAL CONTACTS BEING OPERATED BY SOLENOID

RELAY TYPES



- REED RELAYS
  - LOW CURRENT OPERATION
- MERCURY WETTED RELAY

RELAY SELECTION

COIL TYPE - AC/DC, VOLTAGE, CURRENT RESISTANCE

PICK UP VOLTAGE

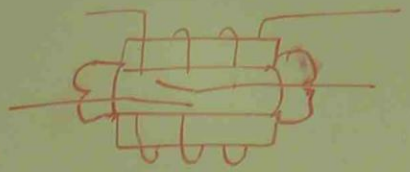
OPERATING / RELEASE TIME

TEMPERATURE RANGE OF USE

CONTACT ARRANGEMENT

CONTACT CURRENT RATING.

RELAY TYPES



- REED RELAYS
  - LOW CURRENT OPERATION
- MERCURY WETTED RELAY

RELAY SELECTION

COIL TYPE - AC/DC, VOLTAGE, CURRENT RESISTANCE

PICK UP VOLTAGE

OPERATING | RELEASE TIME

TEMPERATURE RANGE OF USE

CONTACT ARRANGEMENT

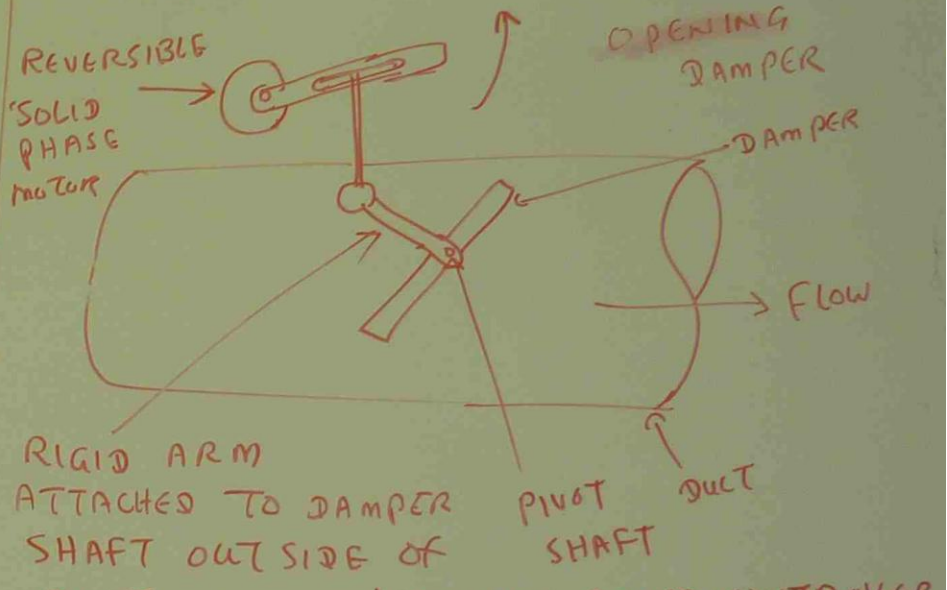
CONTACT CURRENT RATING.

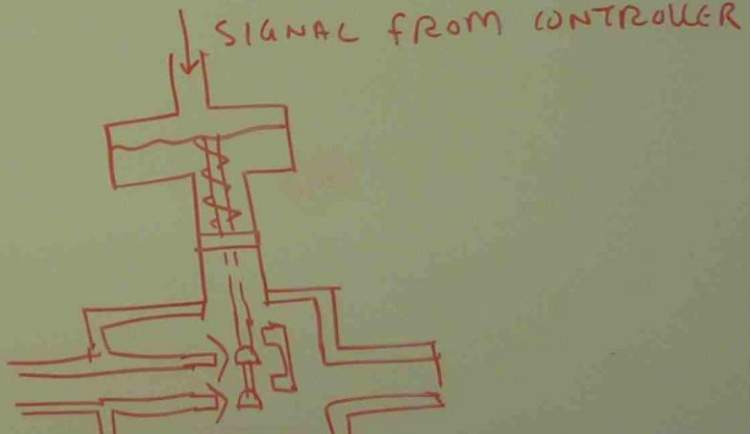
VALVES

ELECTRICAL

PNUEMATIC

A CONTROL VALVE IS A DEVICE WHICH VARIES THE FLOW OF A PROCESS IN RESPONSE TO A CONTROL SIGNAL

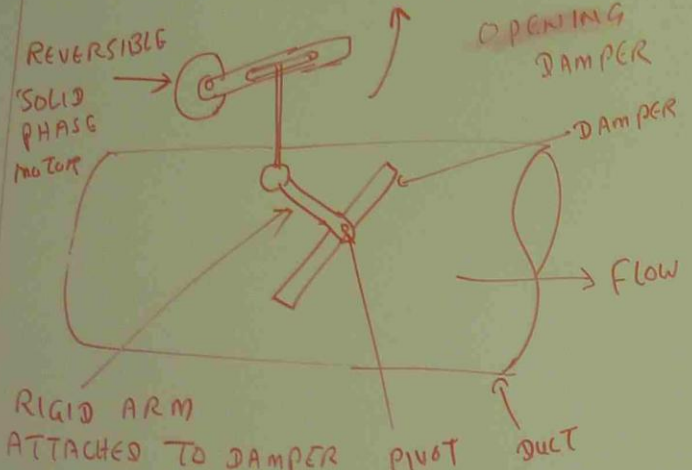


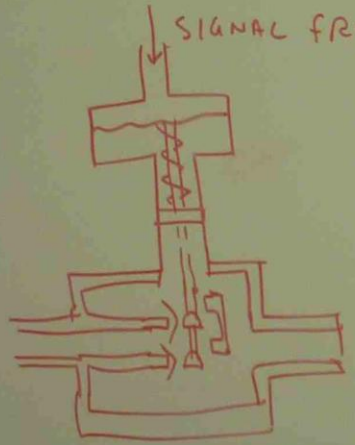


VALVES

- ELECTRICAL
- PNUEMATIC (20kPa → 100kPa)
- (HYDRAULIC)

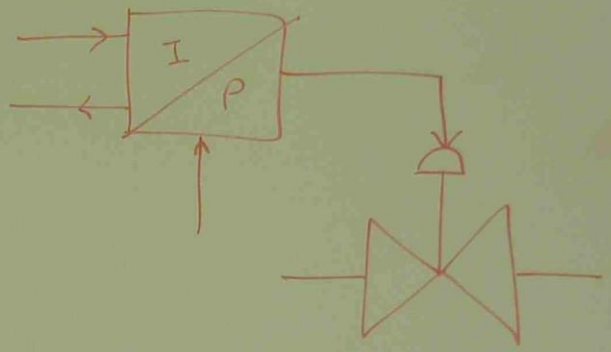
A CONTROL VALUE IS A DEVICE WHICH VARIES THE FLOW OF A PROCESS IN RESPONSE TO A CONTROL SIGNAL



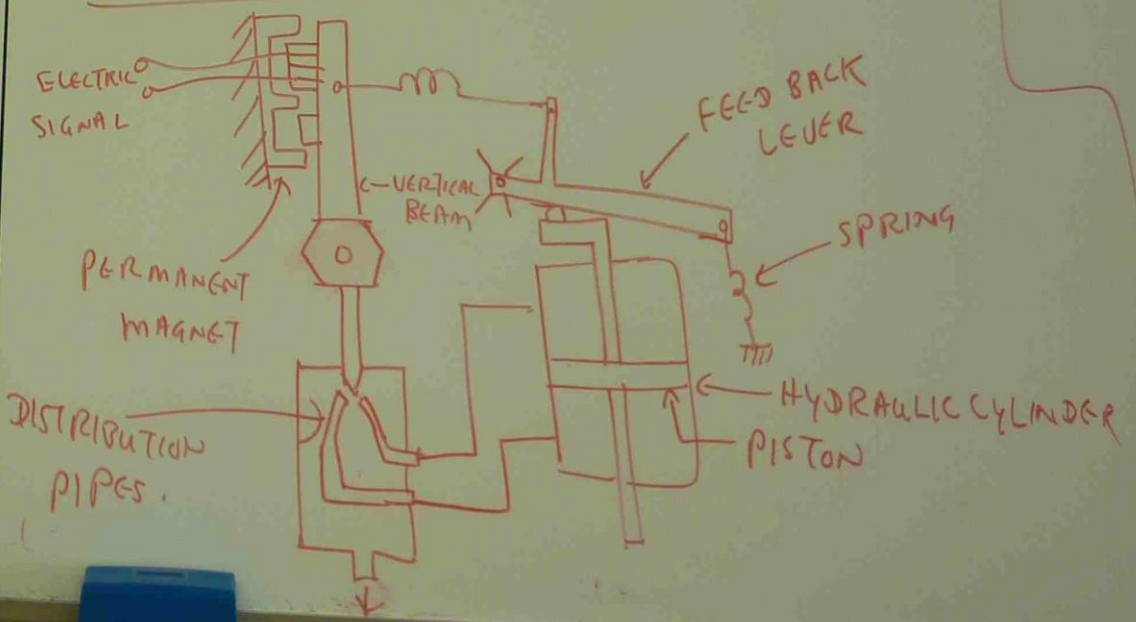


I/P CONVERTER

I/P - CURRENT TO PRESSURE CONVERTER



HYDRAULIC VALVE



CONVERTER

FEED BACK LEVER

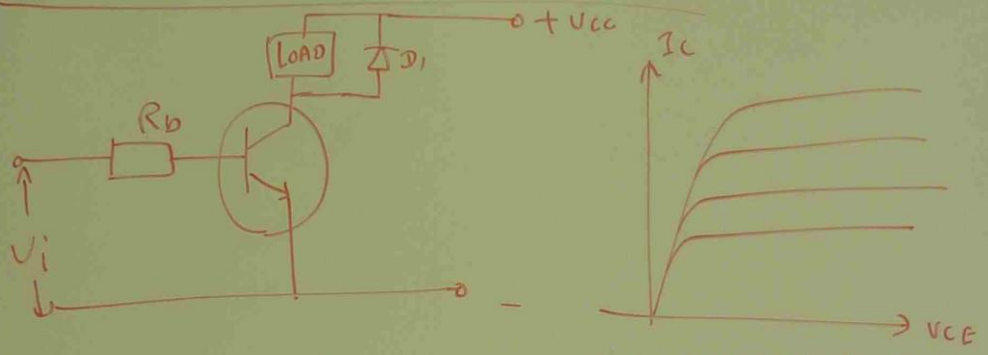
SPRING

HYDRAULIC CYLINDER

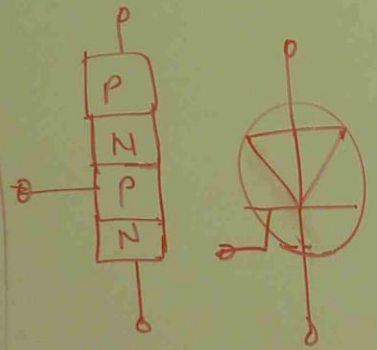
PISTON

SOLID STATE SWITCHING SYSTEM

BIPOLAR JUNCTION TRANSISTOR (BJT)

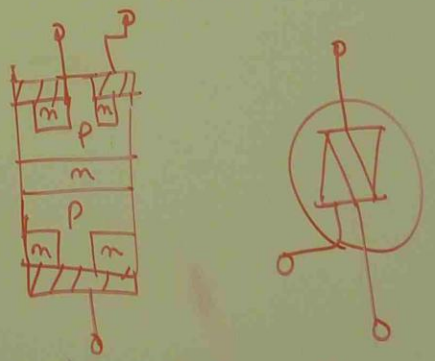


THYRISTER (SILICON CONTROLLED RECTIFIER) (SCR)

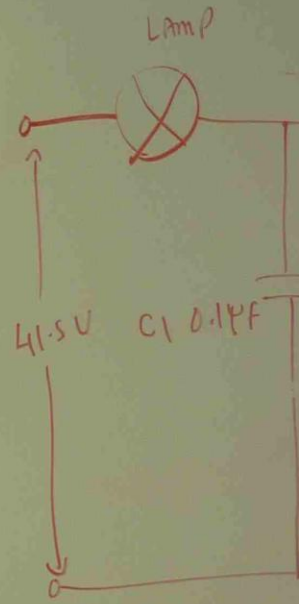


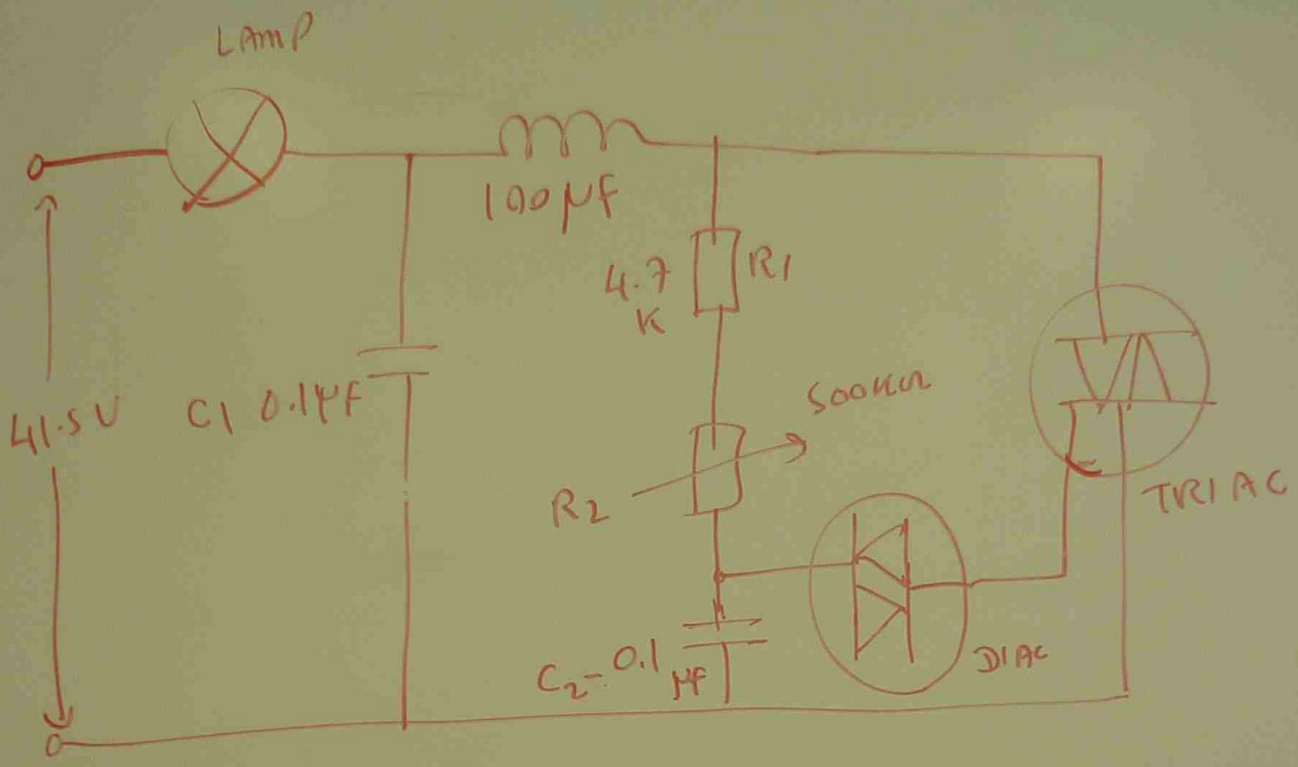
STRUCTURE SYMBOL

TRIAC (BI DIRECTIONAL THREE TERMINAL DEVICES)

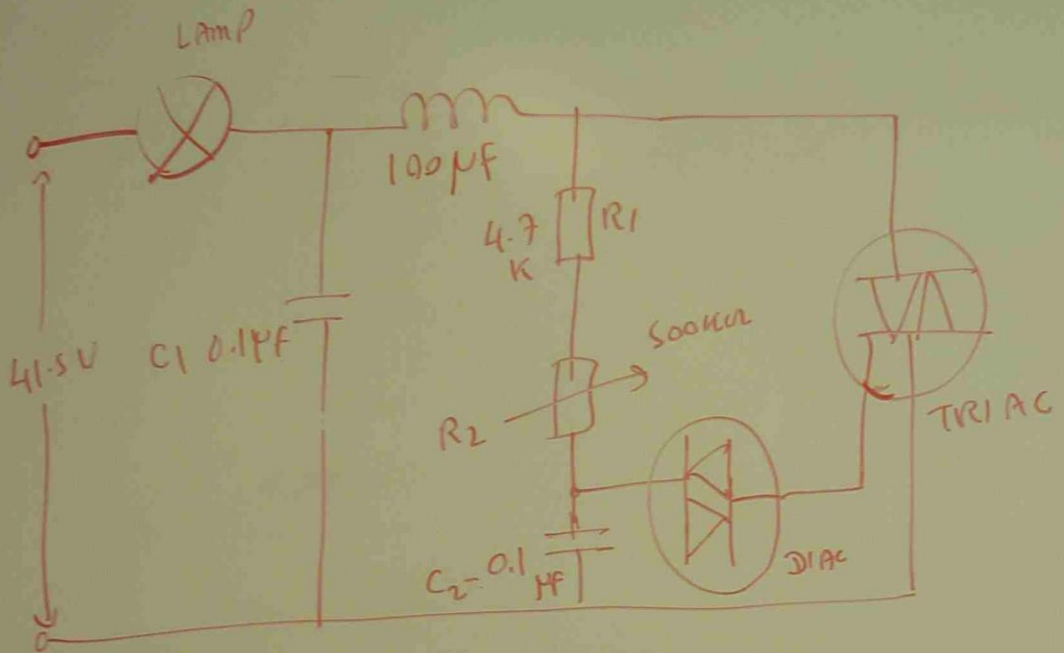


STRUCTURE SYMBOL

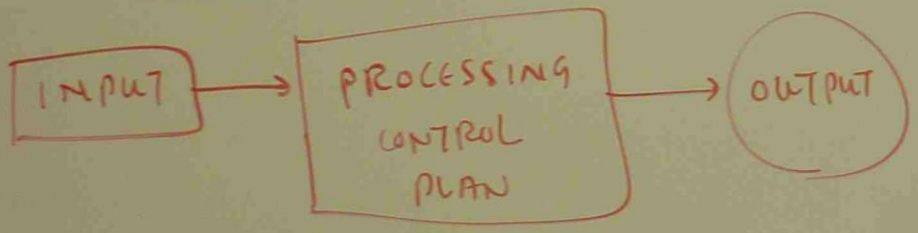




VICES)



AUTOMATIC CONTROL



INPUT

TRANSDUCERS. CONVERT PHYSICAL QUANTITIES TO ELECTRICAL SIGNAL

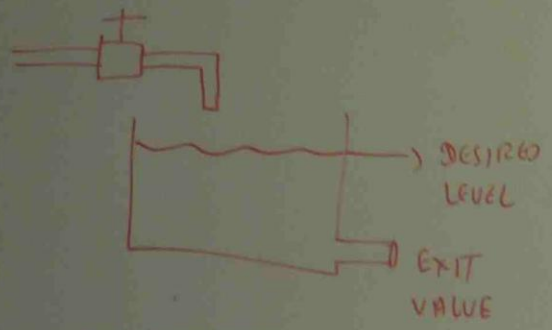
OUTPUT

- FINAL CONTROL ELEMENTS.
- CONVERT OUTPUT SIGNAL TO CONTROL THE PROCESS.

OPEN LOOP CONTROL

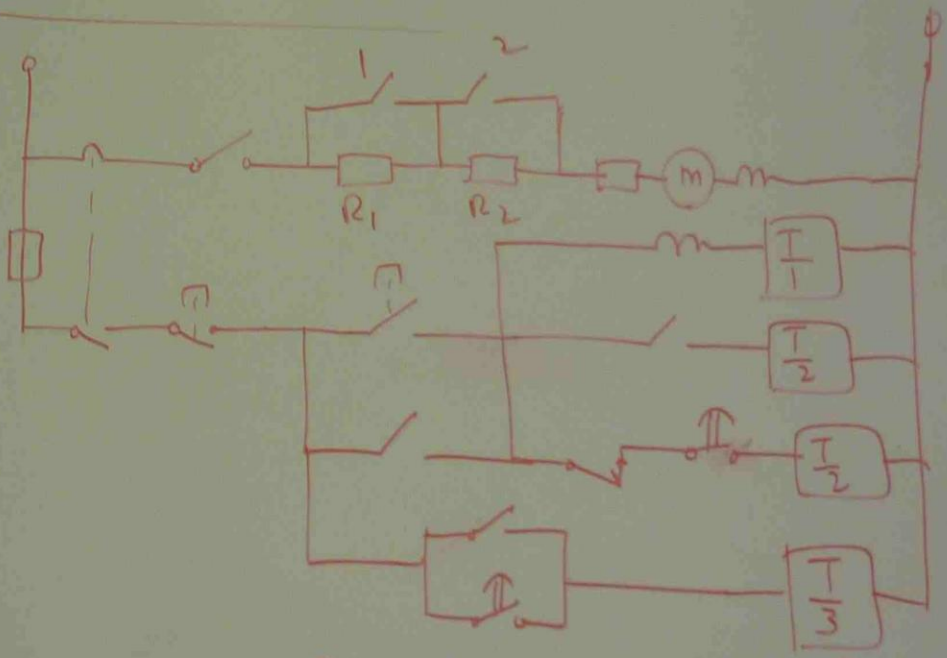
- DOES NOT USE A COMPARISON OF THE ACTUAL RESULT AND DESIRED RESULT TO DETERMINE THE CONTROL ACTION.
- NO FEED BACK IS USED.

WATER TANK



DC MOTOR SPEED CONTROL - RHEOSTAT

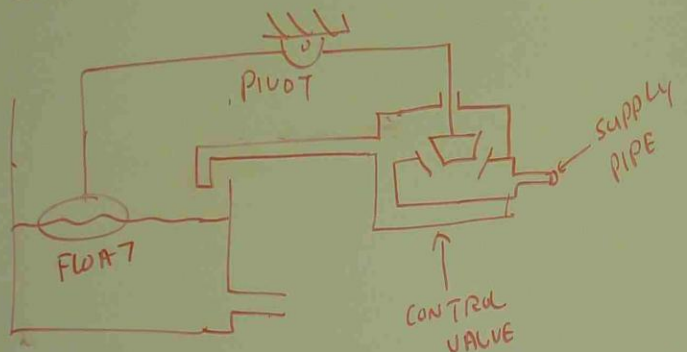
AUTOMATIC MOTOR STARTER TIME LIMIT



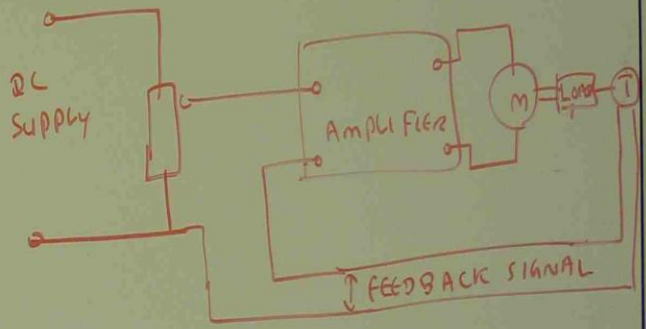
TIMER

CLOSED LOOP CONTROL

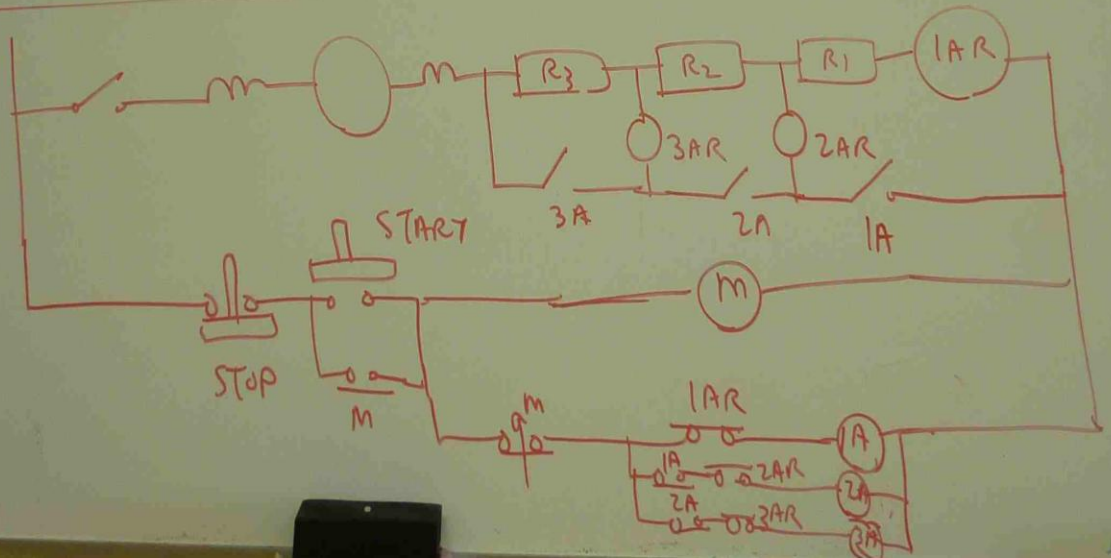
- TO ENSURE THE CONTROL SYSTEM RESPONDS CORRECTLY TO CHANGES IN LOAD (DISTURBANCE) IN SUCH A WAY THAT OUT PUT PERFORMANCE DOES NOT VARY BEYOND CERTAIN PRE-DETERMINED LIMIT (SET POINT)



DC MOTOR SPEED CONTROL

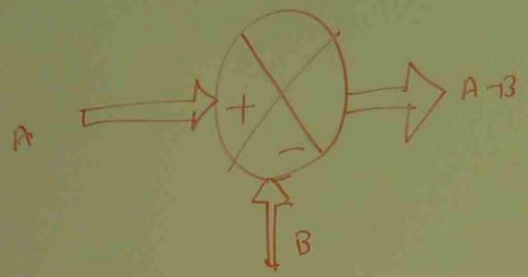


AUTOMATIC MOTOR STARTER - CURRENT LIMIT



100K

REQUIREMENT OF CLOSED LOOP CONTROL



TACHO GENERATOR

REFERENCE — SET POINT

SENSING DEVICE (SENSOR) — PRODUCE THE CORRECTIVE INFORMATION TO SENSOR

CONTROLLER — RESPONSES TO THE SIZE OF THE ERROR AND POLARITY (OR) DIRECTION OF ERROR

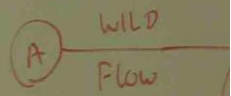
FEEDBACK

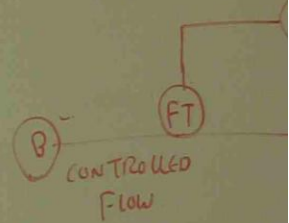
- POSITIVE — IN PHASE WITH OUTPUT, REINFORCE OUTPUT, INCREASE GAIN — INACCURACY, SLOW RESPONSE, INSTABILITY
- NEGATIVE — 180 OUT OF PHASE WITH OUTPUT, OPPOSE THE OUTPUT, DECREASE GAIN — GREATER ACCURACY, FASTER RESPONSE, STABILITY

REVIEW QUEST

(1) A BASIC RAT

OF APPLICATION





OPERATION

FLOW (B) IS CON

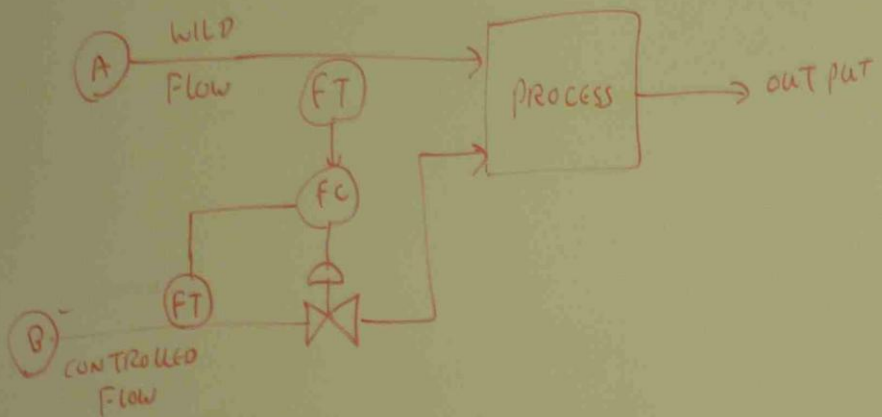
FLOW (A) IS UN

CONTROLLED F

APPLICATION

REVIEW QUESTIONS

(1) A BASIC RATIO CONTROL LOOP IS SHOWN BELOW. BRIEFLY OUTLINE IT'S PRINCIPLE OF APPLICATION AND STATE TWO COMMON APPLICATIONS OF RATIO CONTROL.



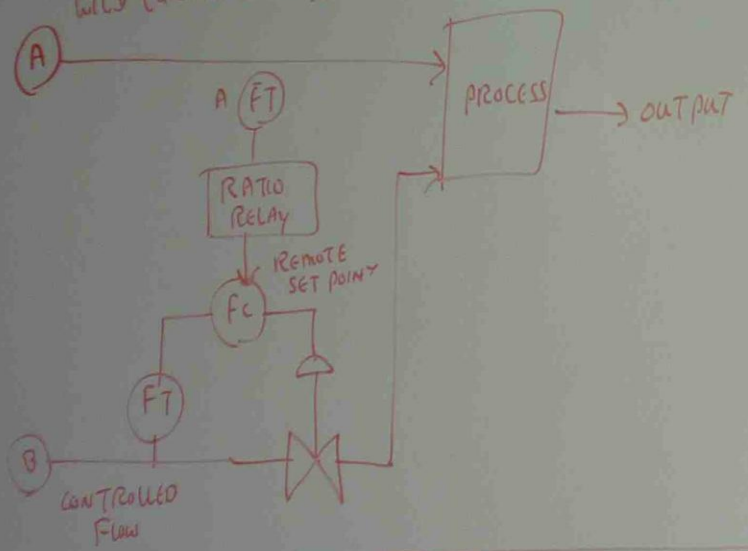
OPERATION

FLOW (B) IS CONTROLLED TO MAINTAIN A FIXED RATIO TO FLOW (A)

FLOW (A) IS UNCONTROLLED. IT IS USED TO SET THE SET POINT OF CONTROLLED FLOW (B)

APPLICATION MIXING of TWO (OR) MORE LIQUIDS.

(2) IN ABOVE DIAGRAM, INSERT A RATIO RELAY (OR) CONTROLLER

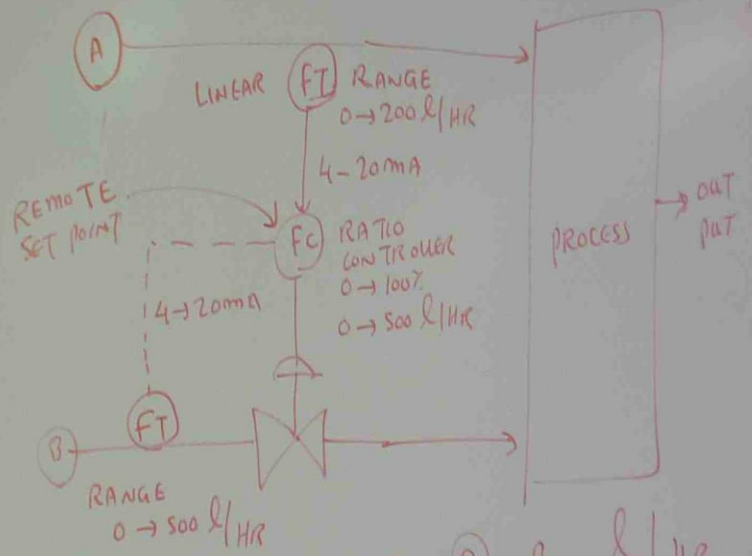


(3) A RATIO CONTROL LOOP IS SHOWN BELOW. EXAMINE THE DIAGRAM AND ANSWER THE FOLLOWING QUESTIONS.

(a) IF THE RATIO IS SET TO 1:1 (X_1)

IF FLOW (A) IS INCREASED BY 20 ℓ/HR

FIND THE % INCREASE IN REMOTE SET POINT SIGNAL.



(b) % INCREASE IN FLOW (B) & ℓ/HR

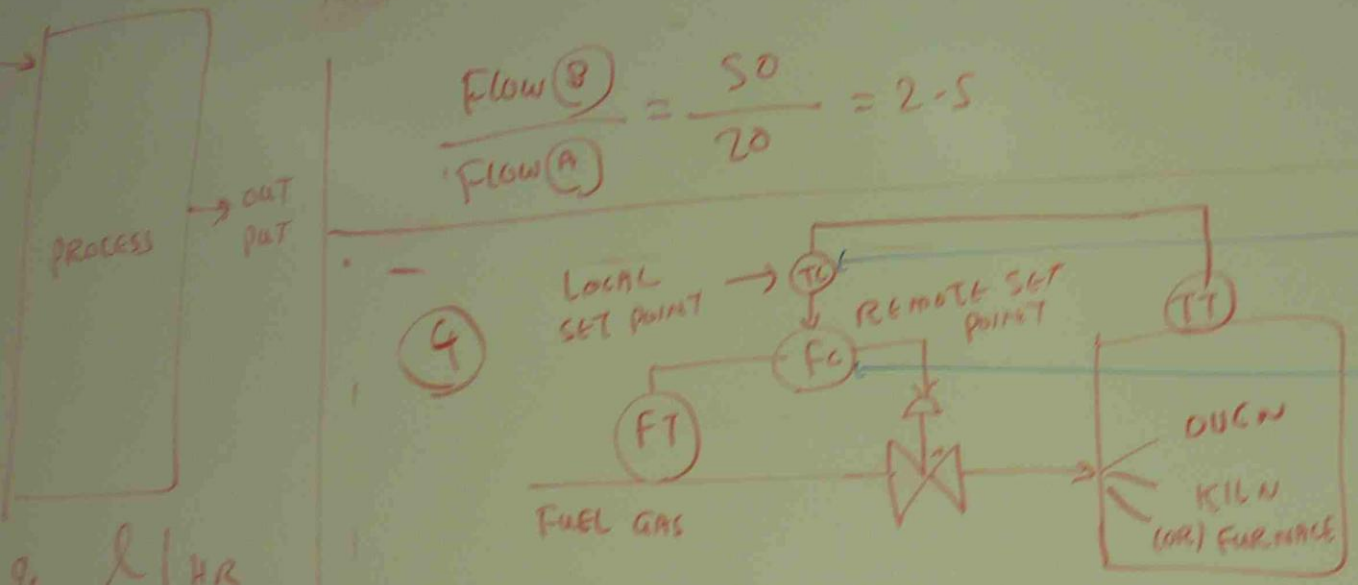
(c) RATIO of FLOW (B) AND (A)

(a) (A) INCREASE 20 ℓ/HR → RATIO = $\frac{20\ \ell/HR\ (INCREASE)}{200\ \ell/HR\ (MAXIMUM)} = 0.1\ (10\%)$

1:1 → (B) ALSO INCREASES 10%.

(b) (B) $\ell/HR = \frac{1}{10} \times 500\ \ell/HR = 50\ \ell/HR$

$$\frac{\text{Flow (B)}}{\text{Flow (A)}} = \frac{50}{20} = 2.5$$



(c)

FT - FLOW TRANSMITTER

FC - FLOW CONTROLLER

A CASCADE CONTROL LOOP IS SHOWN ABOVE

(a) LABEL THE MASTER CONTROLLER

(b) LABEL THE SLAVE CONTROLLER

(c) LIST THE COMPONENTS OF THE SLAVE LOOP

(d) BRIEFLY EXPLAIN THE OPERATION OF CASCADE LOOP

(e) TIME CONSTRAINTS OF MASTER & SLAVE LOOP

(f) WHY MAY A CASCADE LOOP PROVIDE BETTER CONTROL THAN A SINGLE FEEDBACK LOOP

(g) WHY CASCADE CONTROL LOOP IS NECESSARY IN PROCESS

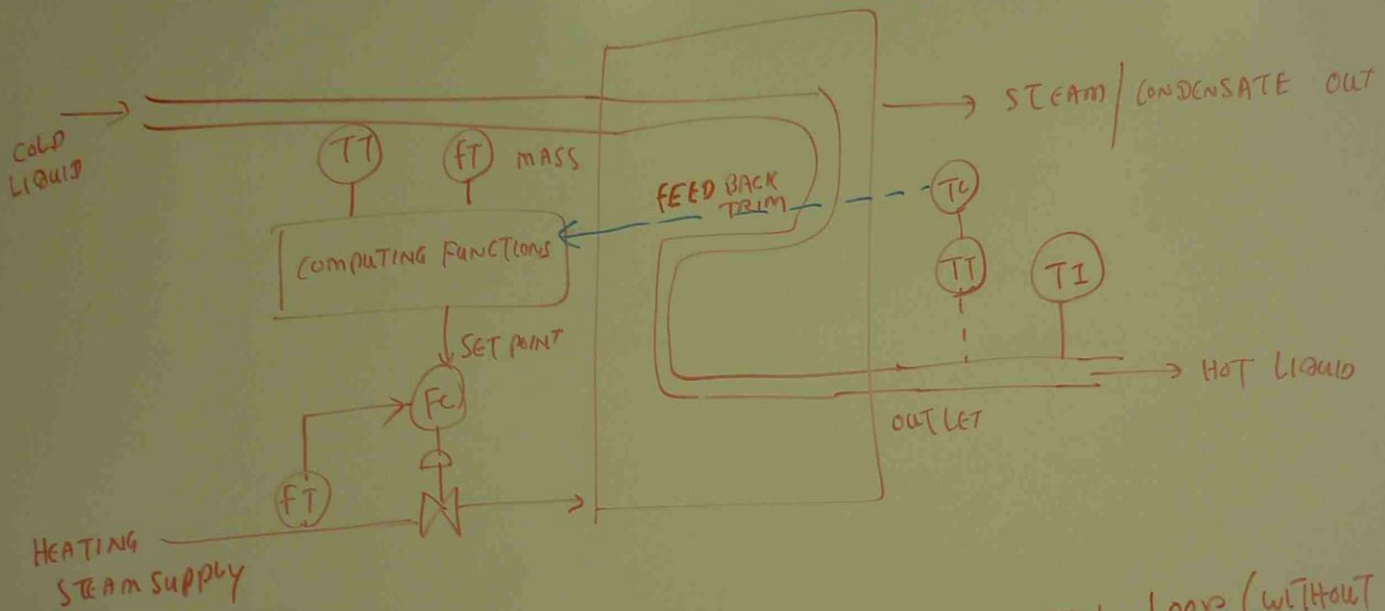
(d) OPERATION

WHEN TEMPERATURE INCREASES IN OVEN, (TT) IS INCREASED. THE INCREASE SIGNAL IS SENT TO (TC), (TC) SENT THE THE INCREASE SIGNAL TO (FC). (FC) DECREASES THE AMOUNT OF LIQUID PASSING THE CONTROL VALVE.

(e) SLAVE LOOP MUST HAVE THE SHORTER TIME CONSTANT THAN MASTER LOOP

(f) IN THIS SYSTEM, THE MORE IMPORTANT FACT IS TO CONTROL THE TEMPERATURE WHICH IS INFLUENCED BY FLOW RATE. APPLYING THE CASCADE SYSTEM TO SENSE THE TEMPERATURE WHICH CAN THEN REGULATES THE RATE OF FLOW CAN PROVIDE THE BETTER CONTROL FUNCTION THAN DIRECT SENSING AND CONTROLLING THE FLOW RATE.

(5) SKETCH A SIMPLE FEED FORWARD CONTROL TEMPERATURE LOOP



(6) SKETCH A SIMPLE FEED FORWARD LEVEL CONTROL LOOP (WITHOUT FEED BACK TRIM)